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AUTHOR Williams, Robert C.
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ABSTRACT

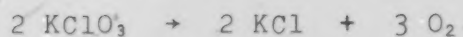
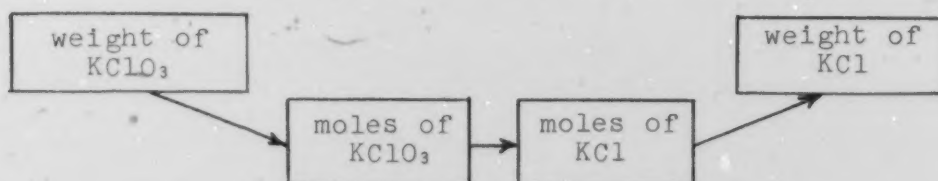
Presented are the teacher's guide and student manual for one of a series of self-instructional, computer-based learning modules for an introductory, undergraduate chemistry course. The student manual for this unit on solving stoichiometry problems includes objectives, prerequisites, pretest, discussion, and 20 problem sets. Included in the teacher's guide are implementation instructions, answers to problem sets, software, sample run, computer program listing in BASIC, and 10 unit tests. (BT)

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STOICHIOMETRY

UNIT 2. SOLVING STOICHIOMETRY PROBLEMS

ROBERT C. WILLIAMS
UNIVERSITY OF NEBRASKAA COMPUTER-ENRICHED MODULE
FOR INTRODUCTORY CHEMISTRY55 g KClO_3 produces ? g KCl U.S. DEPARTMENT OF HEALTH,
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OBJECTIVES

When you finish this unit you will be able to

1. solve simple stoichiometry problems.
2. gain greater proficiency converting between moles, mass, number of atoms or molecules.
3. calculate for a balanced chemical equation
 - a. how much of a chemical substance will react with a specified amount of a different chemical substance
 - b. how much of a chemical substance can be produced from a specified amount of a different chemical substance
 - c. how much of a chemical substance is needed to produce a specified amount of a different chemical substance
4. use the concept of "limiting reagent".
5. learn what theoretical and actual yields are.
6. calculate a percent yield.

PREREQUISITES

Before you start this unit you should know unit conversion and the mole concept.

PRE-TEST

1. Given that 1 mile = 5280 feet, 1 foot = 12 inches, 1 inch = 2.54 centimeters, 100 centimeters = 1 meter, and 1000 meters = 1 kilometer, calculate the number of kilometers which is equivalent to 60 miles.
2. How many molecules are in 2.5 moles of H_2O ?
- *3. What volume in liters (at STP) will 2.5 moles of Cl_2 gas occupy?
4. What is the weight in grams of 2.5 moles H_2O ?
- *5. How many moles of Cl_2 gas occupy 11.2 liters at STP?
6. How many moles are equal to 6.0 g H_2O ?
7. How many moles are 3.0×10^{24} atoms of Ne?

Answers to pre-test:

$$1. \quad 60 \text{ mi} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = 96.6 \text{ km}$$

$$2. \quad 2.5 \text{ moles } \text{H}_2\text{O} \times \frac{6.0 \times 10^{23} \text{ molecules } \text{H}_2\text{O}}{1 \text{ mole } \text{H}_2\text{O}} = 1.5 \times 10^{24} \text{ molecules } \text{H}_2\text{O}$$

$$3. \quad 2.5 \text{ moles } \text{Cl}_2 \times \frac{22.4 \text{ l } \text{Cl}_2 \text{ at STP}}{1 \text{ mole } \text{Cl}_2} = 56.0 \text{ l } \text{Cl}_2 \text{ at STP}$$

*Optional. Answer these if you have worked on molar volumes of gases.

$$4. \quad 2.5 \text{ moles H}_2\text{O} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 45.0 \text{ g H}_2\text{O}$$

$$5. \quad 11.2 \text{ l Cl}_2 \text{ at STP} \times \frac{1 \text{ mole Cl}_2}{22.4 \text{ l Cl}_2 \text{ at STP}} = 0.5 \text{ moles Cl}_2 \text{ at STP}$$

$$6. \quad 6.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mole H}_2\text{O}}{18 \text{ g H}_2\text{O}} = 0.33 \text{ moles H}_2\text{O}$$

$$7. \quad 3.0 \times 10^{24} \text{ atoms Ne} \times \frac{1 \text{ mole Ne}}{6.0 \times 10^{23} \text{ atoms Ne}} = 5.0 \text{ moles Ne}$$

INTRODUCTION

"Stoichiometry" is a chemist's name for the quantitative measurement and determination of relationships between chemical substances. Stoichiometry problems are "how much?" problems. The ability to solve such problems is essential to understanding and doing chemistry.

DISCUSSION

Solving a stoichiometry problem is like driving a car. Both tasks require the user to learn a rather rigid set of rules before proceeding further, and both tasks eventually become so familiar as to become second nature to the user. If a car driver attempts a shortcut in unknown territory or without consulting a map, he or she is apt to become hopelessly lost. Similarly, a chemist who attempts to solve a stoichiometry problem without first mapping out an appropriate solution route is apt to be unsuccessful.

The chemist, however, has a significant advantage over the automobile driver. Although road maps will change drastically depending on geographical terrain, most stoichiometry problems are sufficiently similar to use essentially the same general solution map every time.

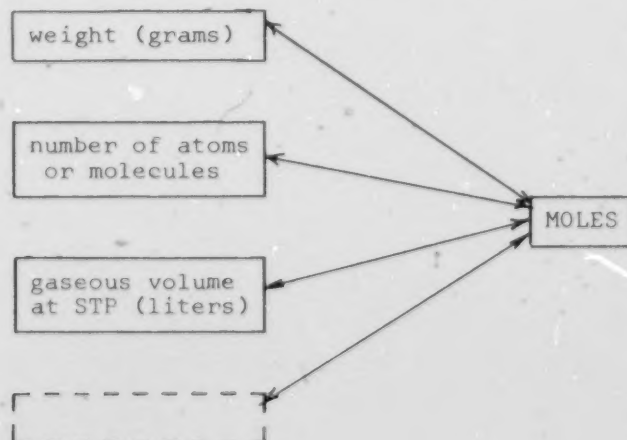


Figure 1. A road map for solving problems involving moles.

The map indicates possible conversion paths between different units, the dotted box represents any other units which may arise in a problem. Using the map, it is possible to systematically convert units, by applying the correct conversion factors in the order specified by the map. For example, suppose you want to know how many molecules are in 33.6 g of N_2 gas. Starting from weight of N_2 , the map indicates that you should first convert to moles, and then convert to the number of molecules.



Figure 2. A map for conversion between weight in grams and number of molecules.

Since we know that 28.0 g of N_2 = 1 mole and that 1 mole = 6.0×10^{23} molecules, we can solve the problem as follows:

$$33.6 \text{ g } N_2 \times \frac{1 \text{ mole } N_2}{28.0 \text{ g } N_2} \times \frac{6.0 \times 10^{23} \text{ molecules } N_2}{1 \text{ mole } N_2} = 7.2 \times 10^{23} \text{ molecules } N_2.$$

If a chemical reaction occurs, then there are usually two or more chemical species of interest, and it is often necessary to convert units from one species to the others. In this case, we use the road map shown in Figure 2. Here, "A" and "B"

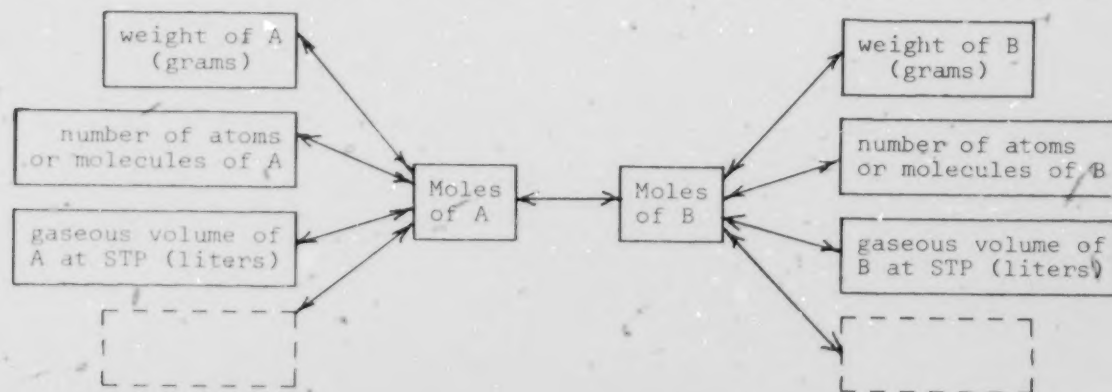


Figure 3. A problem solution map for conversion between different chemical species.

are used to indicate any two chemical species involved. The use of this map is essentially identical to that of Figure 1. It is in fact made up of two simple maps (one for A, one for B) side by side. Suppose, for example, that you want to know what weight of oxygen can be collected from the electrolysis of 9.0 g H_2O , given the equation



If we take H_2O to be substance A, and O_2 to be substance B, the solution map is:

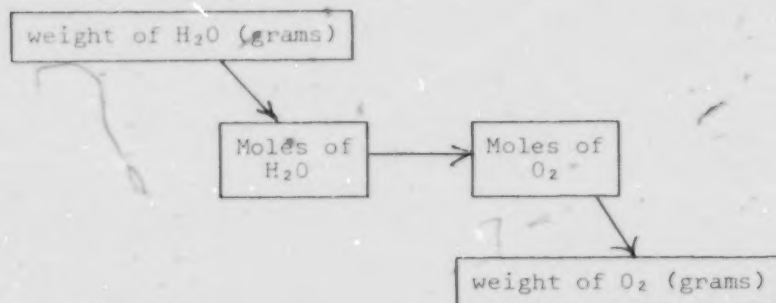


Figure 4. A map for determining weight of oxygen produced by electrolysis of water.

The necessary conversion factors are $18 \text{ g H}_2\text{O} = 1 \text{ mole H}_2\text{O}$, $2 \text{ moles H}_2\text{O} = 1 \text{ mole O}_2$, and $1 \text{ mole O}_2 = 32 \text{ g O}_2$. The unit conversion process is

$$9.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mole H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{1 \text{ mole O}_2}{2 \text{ moles H}_2\text{O}} \times \frac{32 \text{ g O}_2}{1 \text{ mole O}_2} ,$$

and the final answer is 8.0 g O_2 .

Occasionally, it is necessary to add an additional box (or boxes) to the map. Suppose the answer to this example was desired in milligrams. A solution map including this extra step is shown below:

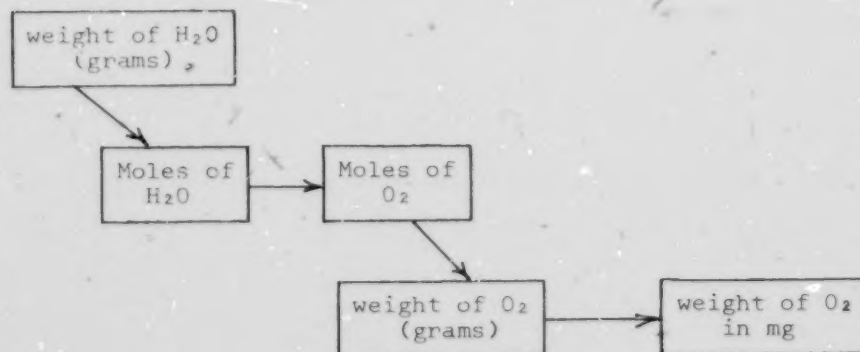


Figure 5. A map for determining weight of oxygen in milligrams produced by electrolysis of water.

The unit conversion chain will be:

$$9.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mole H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{1 \text{ mole O}_2}{2 \text{ moles H}_2\text{O}} \times \frac{32 \text{ g O}_2}{1 \text{ mole O}_2} \times \frac{1000 \text{ mg O}_2}{1 \text{ g O}_2} = 8.0 \times 10^3 \text{ mg} .$$

The map serves as a guide in proceeding from what is given through various steps to the desired answer. After some experience you will be able to do this without being conscious of all the boxes, but for now let us outline a set of logical steps for calculating the answer:

- Step 0. If a chemical reaction is involved, write down the balanced equation for that reaction.
- Step 1. Identify what is given and what is wanted.
- Step 2. From the general solution map, determine a path which will lead from what is given to what is wanted.
- Step 3. For each step in the solution map, apply the needed conversion factor.
- Step 4. Complete all arithmetic operations and record the final result.

Step Zero: If a chemical reaction is involved, write down the balanced equation for that reaction.

This is needed only when it's necessary to convert between different chemical species. If you have already studied how to balance chemical equations, your teacher may ask you to complete and balance the equation. However, all the problems in this module will give you the balanced equation.

Step One: Identify what is given and what is wanted.

This one is important, but frequently overlooked. If you can't identify what is given and what must be calculated, you can't solve the problem!

Step Two: From the general solution map, determine a path which will lead from what is given to what is wanted.

This serves to organize the problem solution process in a systematic and logical manner. Use the map from Figure 1 when only one chemical species is present, use the map from Figure 2 when you must convert between different chemical species.

Step Three: For each step in the solution map, apply the needed conversion factor.

This is the key step in this method of problem solving, and consists of a series of unit conversions. Application of a conversion factor does not actually change the amount of a substance, but yields an equivalent way of stating that amount. (Whether a distance is expressed as 50 miles or 80 kilometers, it remains the same distance.) When only one chemical substance is involved, this method yields an alternate way of specifying the same amount of substance. When two chemical species are involved, this method tells how much of substance B is equivalent (equal) to so much of substance A. The conversion factor between different chemical species is obtained from the coefficients of the balanced chemical equation, the conversion factors between other units are calculated in the standard fashion. Review the module on unit conversions for further explanation of the latter.

Step Four: Complete all arithmetic operations and record the final result.

Review the two example problems to see how the steps are applied. The next two problems show additional examples of stoichiometry problems.

Example 3. Potassium chlorate (KClO_3) decomposes on heating to yield potassium chloride (KCl) and oxygen (O_2), according to the equation



How much potassium chlorate was present (grams), if after heating, 37.28 g potassium chloride was left?

Step 0.



Step 1.

Given 37.28 g of KCl (substance A)

Find g of KClO_3 (substance B)

Step 2.

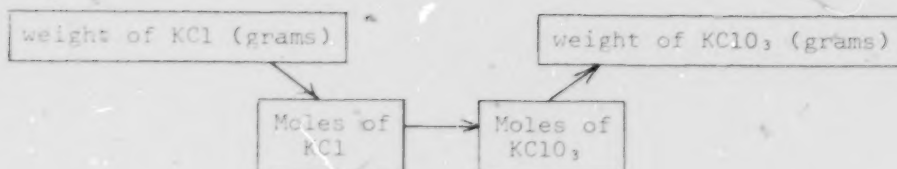


Figure 8. A map for calculation of weight of KClO_3 produced from KCl .

For convenience, we can rewrite this on one line, without the boxes as
 g KCl $\rightarrow$ moles KCl $\rightarrow$ moles KClO_3 $\rightarrow$ g KClO_3 .

We will use this more convenient notation in later problems.

Step 3.

The conversion factors are

1 mole KCl = 74.55 g KCl (the molecular weight of KCl)

2 moles KClO_3 = 2 moles KCl (from the balanced chemical equation)

1 mole KClO_3 = 122.55 g KClO_3 (the molecular weight of KClO_3)

Applying these conversion factors yields

$$37.28 \text{ g KCl} \times \frac{1 \text{ mole KCl}}{74.55 \text{ g KCl}} \times \frac{2 \text{ moles KClO}_3}{2 \text{ moles KCl}} \times \frac{122.55 \text{ g KClO}_3}{1 \text{ mole KClO}_3}$$

Step 4.

$$\frac{37.28 \times 122.55 \text{ g KClO}_3}{74.55} = 61.28 \text{ g KClO}_3$$

Example 4. Soft coal contains iron pyrite, FeS_2 . When soft coal is burned, the atmospheric pollutant SO_2 is formed, according to the equation



How many grams of sulfur dioxide will be formed when 5 kilograms of coal containing 5% FeS_2 is burned?

Step 0.



Step 1.

Given 5 kg of 5% FeS₂

Find weight (g) of SO₂

Step 2.

Notice that two additional boxes are necessary in the map:

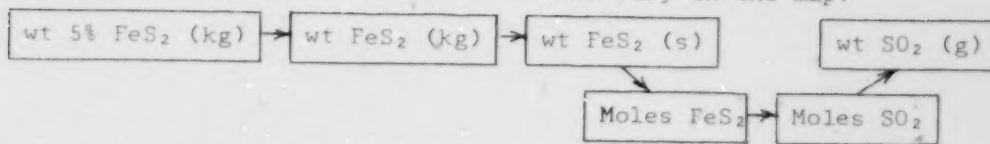


Figure 7. A map to calculate weight SO₂ produced from FeS₂.

Using the more convenient notation introduced in the last example, this becomes

kg 5% FeS₂ + kg FeS₂ + g FeS₂ + moles FeS₂ + moles SO₂ + g SO₂.

The order of the first two steps is not critical. We could just as easily calculate grams of 5% FeS₂ first, and then calculate grams of pure FeS₂; the final result will be the same in either case.

Step 3:

The conversion factors are

$$100 \text{ kg } 5\% \text{ FeS}_2 = 5 \text{ kg FeS}_2$$

$$1 \text{ kg FeS}_2 = 1000 \text{ g FeS}_2$$

$$119.8 \text{ g FeS}_2 = 1 \text{ mole FeS}_2$$

$$4 \text{ moles FeS}_2 = 8 \text{ moles SO}_2$$

$$64 \text{ g SO}_2 = 1 \text{ mole SO}_2$$

Application of these conversion factors yields

$$5 \text{ kg } 5\% \text{ FeS}_2 \times \frac{5 \text{ kg FeS}_2}{100 \text{ kg } 5\% \text{ FeS}_2} \times \frac{1000 \text{ g FeS}_2}{1 \text{ kg FeS}_2} \times \frac{1 \text{ mole FeS}_2}{119.8 \text{ g FeS}_2} \times \frac{8 \text{ moles SO}_2}{4 \text{ moles FeS}_2} \times \frac{64 \text{ g SO}_2}{1 \text{ mole SO}_2}$$

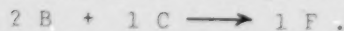
The most common mistake students make is to forget to write the complete units. If, for example, you forget to label the kind of moles, you may accidentally try to convert moles of FeS₂ directly to g SO₂, in which case your answer will be 50% low.

Step 4.

$$\frac{5 \times 5 \times 1000 \times 8 \times 64}{100 \times 119.8 \times 4} \text{ g SO}_2 = 267 \text{ g SO}_2$$

LIMITING REAGENT

Suppose you have an assortment of empty, two-cell flashlight cases (C), and D-cell batteries (B). For each two batteries and one flashlight case, you can make one working flashlight (F), according to the equation



How many working flashlights can you make from two cases and six batteries?

How many from three cases and four batteries? In each case, the answer is two

working flashlights. In each case, there are some parts left over. However, these extra parts cannot be used, because the other component, the "limiting reagent" has been completely used up.

The physical and chemical definitions of limiting reagent are essentially identical: the limiting reagent is the substance which is used up first; the amount of product is limited by this reagent, regardless of any excess in the other chemicals. Note that the limiting reagent is not always the smaller amount physically: in the second flashlight example, the number of batteries is the limiting quantity, even though there are four batteries, and only three flashlight cases.

Example 5. Methane gas (CH_4) reacts with oxygen (O_2) to yield carbon dioxide (CO_2) and water. What weight of water will be produced from 8.0 g methane, and 64 g O_2 ?

Step 0.

The complete balanced equation is



Using CH_4 :

Step 1. Given 8.0 g CH_4
Find g of H_2O

Step 2. g CH_4 + moles CH_4 +
+ moles H_2O + g H_2O

Step 3. 16 g CH_4 = 1 mole CH_4
1 mole CH_4 = 2 moles H_2O
1 mole H_2O = 18 g H_2O

$$8 \text{ g CH}_4 \times \frac{1 \text{ mole CH}_4}{16 \text{ g CH}_4} \times \frac{2 \text{ moles H}_2\text{O}}{1 \text{ mole CH}_4} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}}$$

$$\text{Step 4. } \frac{8 \times 2 \times 18}{16} \text{ g H}_2\text{O} = 18 \text{ g H}_2\text{O}$$

Using O_2 :

Given 64 g O_2
Find g H_2O

g O_2 + moles O_2 +
+ moles H_2O + g H_2O

32 g O_2 = 1 mole O_2
2 moles O_2 = 2 moles H_2O
1 mole H_2O = 18 g H_2O

$$64 \text{ g O}_2 \times \frac{1 \text{ mole O}_2}{32 \text{ g O}_2} \times \frac{2 \text{ moles H}_2\text{O}}{2 \text{ moles O}_2} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}}$$

$$\frac{64 \times 2 \times 18}{32 \times 2} \text{ g H}_2\text{O} = 36 \text{ g H}_2\text{O}$$

We see that the limiting reagent is methane, since it limits the amount of product to 18 g of H_2O , even though there is enough O_2 to produce 36 g H_2O . The correct answer is 18 g H_2O . Note that the last term in Step 3 is the same for both reactions. For this reason, a simple approach to this problem would be to solve for the number of moles of water produced in each case. (The limiting reagent is the one which produces the smaller number of moles of water.) Then convert the smaller of these to grams of water. It is often possible to detect the limiting reagent by inspection of the two conversion factor expressions, so that only one set of calculations actually has to be carried out.

For example, we could do this same problem by inspecting the proportion of reactants which are needed and comparing this to the proportion of reactants actually present:

needed proportion of reactants is:

$$\frac{1 \text{ mole of CH}_4}{2 \text{ moles of O}_2} \text{ or } 0.50$$

actual proportion of reactants is:

$$\frac{8 \text{ g of CH}_4 / 16 \text{ g mole}^{-1} \text{ of CH}_4}{64 \text{ g of O}_2 / 32 \text{ g mole}^{-1} \text{ of O}_2} = 0.25$$

We see that 0.25 is less than 0.50. Therefore, there is not enough CH₄ present to react with all of the O₂ supplied. Thus, CH₄ is the limiting reagent. We then proceed as usual to find the grams of H₂O produced from 8.0 g of CH₄.

PERCENT YIELD

Sometimes there are discrepancies between the calculated yield and measured yields in a chemical reaction. The calculated or theoretical yield is the number which is calculated, knowing the amount of starting materials. The actual measured yield is usually less than this. The difference between the calculated and theoretical yield is that small amount that you couldn't scrape out of the flask, or that evaporated, or that you accidentally poured down the sink. For a pure product, the actual yield will always be less than, or equal to, the theoretical yield.

It is useful to state the actual yield as a percentage of the theoretical yield. The percent yield is:

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

Example 6. Suppose the actual yield of oxygen gas in Example 2 was 7.8 g. Using the conversion factors we had found that 100% yield was 8.0 g O₂.

$$7.8 \text{ g O}_2 \times \frac{100\% \text{ yield}}{8.0 \text{ g O}_2} = 97.5\% \text{ yield}$$

Problem Set 1

1.



IF WE START WITH 53.00 G OF H_3PO_4 AND 4.16 MOLES OF $\text{Ba}(\text{OH})_2$ IN THIS REACTION, AND 15.46 G OF $\text{Ba}_3(\text{PO}_4)_2$ ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

2.



WHEN 4.06 MOLES OF H_2 AND 29.81 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF Fe CAN BE EXPECTED?

3.



WHAT WEIGHT OF NO IS THE THEORETICAL YIELD FROM 33.95 G OF NH_3 AND 2.03 MOLES OF O_2 ?

4.



HOW MANY MOLES OF CO_2 CAN WE EXPECT FROM A REACTION BETWEEN 1.46 MOLES OF C_6H_6 AND 1.09 MOLES OF O_2 ?

5.



HOW MANY MOLES OF CO CAN BE FORMED BY THE REACTION OF 2.59 MOLES OF CaO WITH C IF THE LATTER IS IN EXCESS?

6.



HOW MANY GRAMS OF H_2O ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 2.58 MOLES OF NO, IF THE REACTION HAS A YIELD OF 32.1 % ?

Problem Set 2

1.



IN AN EXPERIMENT, 4.42 MOLES OF CaO ARE TREATED WITH EXCESS C. THE CO OBTAINED WEIGHED 89.85 G. WHAT WAS THE PERCENT YIELD?

2.



IN THIS REACTION, 44.00 G OF XeF₄ AND 53.00 G OF H₂ RESULTS IN AN ACTUAL YIELD OF 88.2 %. HOW MANY GRAMS OF HF ARE OBTAINED?

3.



WHEN 1.32 MOLES OF C₆H₆ AND 45.97 G OF O₂ ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF CO₂ CAN BE EXPECTED?

4.



HOW MANY GRAMS OF H₂O IS THEORETICALLY OBTAINABLE FROM 5.367 G OF 98.999 % PURE H₃PO₄?

5.



WHAT WEIGHT OF NO IS THE THEORETICAL YIELD FROM 21.00 G OF NO₂ AND 2.68 MOLES OF H₂O?

6.



STARTING WITH 10.05 G OF H₃PO₄ AND 15.28 G OF Ba(OH)₂, WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H₂O WHICH CAN BE PRODUCED?

Problem Set 3

1.



H_2O WAS PREPARED BY TREATING 25.00 G OF H_2 WITH EXCESS Fe_2O_3 . THE H_2O COLLECTED WEIGHED 201.82 G. WHAT WAS THE PERCENT YIELD ?

2.



WHEN 4.69 MOLES OF H_2 AND 47.63 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF Fe CAN BE EXPECTED?

3.



HOW MANY MOLES OF PbCl_2 CAN WE EXPECT FROM A REACTION BETWEEN 2.49 MOLES OF PCl_3 AND 2.97 MOLES OF PbF_2 ?

4.



HOW MANY GRAMS OF H_2O IS THEORETICALLY OBTAINABLE FROM 5.867 G OF 87.698 % PURE H_3PO_4 ?

5.



WHAT WEIGHT OF SO_2 IS THE THEORETICAL YIELD FROM 33.45 G OF ZnS AND 4.20 MOLES OF O_2 ?

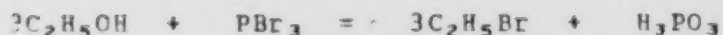
6.



HOW MANY GRAMS OF H_2 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 0.60 MOLES OF Xe, IF THE REACTION HAS A YIELD OF 52.1 % ?

Problem Set 4

1.



WHEN 1.42 MOLES OF $\text{C}_2\text{H}_5\text{OH}$ AND 13.83 G OF PBr_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_3PO_3 CAN BE EXPECTED?

2.



STARTING WITH 52.80 G OF H_2 AND 22.77 G OF Fe_2O_3 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF Fe WHICH CAN BE PRODUCED ?

3.



IN THIS REACTION, 29.00 G OF H_2 AND 46.00 G OF Fe_2O_3 RESULTS IN AN ACTUAL YIELD OF 75.2 %. HOW MANY GRAMS OF H_2O ARE OBTAINED ?

4.



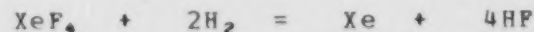
HOW MANY MOLFS OF NO CAN BE FORMED FROM 15.40 G OF NH_3 ?

5.



WHAT WEIGHT OF Fe IS THE THEORETICAL YIELD FROM 20.30 G OF H_2 AND 2.52 MOLES OF Fe_2O_3 ?

6.



Xe WAS PREPARED BY TREATING 30.00 G OF XeF_4 WITH EXCESS H_2 . THE Xe COLLECTED WEIGHED 18.47 G. WHAT WAS THE PERCENT YIELD ?

Problem Set 5

1.



HOW MANY GRAMS OF SO_2 IS THEORETICALLY OBTAINABLE FROM 8.383 G OF 34.799 % PURE ZnS ?

2.



IN THIS REACTION, 26.00 G OF XeF_4 AND 56.00 G OF H_2 RESULTS IN AN ACTUAL YIELD OF 60.5 %. HOW MANY GRAMS OF HF ARE OBTAINED ?

3.



IF WE START WITH 41.75 G OF H_3PO_4 AND 46.14 G OF $\text{Ba}(\text{OH})_2$, WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF H_2O WILL IT PRODUCE ?

4.



WHAT WEIGHT OF CO IS THE THEORETICAL YIELD FROM 26.25 G OF CaO AND 1.82 MOLES OF C ?

5.



A STUDENT REACTS 20.00 G OF XeF_4 WITH 4.00 G OF H_2 . IF THE STUDENT ACTUALLY OBTAINS 5.90 G OF Xe , WHAT IS THE PERCENT YIELD?

6.



STARTING WITH 52.30 G OF NO_2 AND 33.83 G OF H_2O , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED ?

Problem Set 6

1.



IN AN EXPERIMENT, 2.30 MOLES OF PCl_3 ARE TREATED WITH EXCESS PbF_2 . THE PbCl_2 OBTAINED WEIGHED 544.00 G. WHAT WAS THE PERCENT YIELD?

2.



HOW MANY GRAMS OF $\text{C}_2\text{H}_5\text{OH}$ WAS REQUIRED TO MAKE 49.00 G OF $\text{C}_2\text{H}_5\text{Br}$ IF THE YIELD WAS 63.5%?

3.



WHEN 1.48 MOLES OF H_2 AND 10.47 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_2O CAN BE EXPECTED?

4.



HOW MANY MOLES OF H_2O CAN BE FORMED FROM 72.30 G OF O_2 ?

5.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF HNO_3 EXPECTED WHEN 30.55 G OF NO_2 REACTS WITH 21.13 G OF H_2O ?

6.



HOW MANY MOLES OF H_2O CAN WE EXPECT FROM A REACTION BETWEEN 1.84 MOLES OF C_6H_6 AND 1.05 MOLES OF O_2 ?

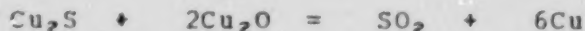
Problem Set 7

1.



STARTING WITH 23.65 G OF NO_2 AND 29.99 G OF H_2O ,
WHAT IS THE MAXIMUM NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED ?

2.



HOW MANY GRAMS OF Cu_2O ARE NEEDED AS THE STARTING MATERIAL
FOR THE PREPARATION OF 1.70 MOLES OF Cu , IF THE REACTION
HAS A YIELD OF 89.7 % ?

3.



PbCl_2 WAS PREPARED BY TREATING 49.00 G OF PCl_3 WITH
EXCESS PbF_2 . THE PbCl_2 COLLECTED WEIGHED 70.70 G.
WHAT WAS THE PERCENT YIELD ?

4.



IF WE START WITH 33.10 G OF PCl_3 AND 10.52 G OF PbF_2 , WHICH IS
THE LIMITING REAGENT AND HOW MANY MOLES OF PbCl_2 WILL IT PRODUCE ?

5.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF CaC_2 EXPECTED WHEN
34.25 G OF CaO REACTS WITH 28.38 G OF C ?

6.



HOW MANY GRAMS OF Xe IS THEORETICALLY
OBTAINABLE FROM 4.719 G OF 64.099 % PURE H_2 ?

Problem Set 8

1.



A STUDENT TAKES 47.50 G OF CaO AND REACTS IT WITH 5.36 MOLES OF C. WHAT IS THE MAXIMUM NUMBER OF GRAMS OF CaC₂ THAT COULD BE FORMED IN THIS EXPERIMENT?

2.



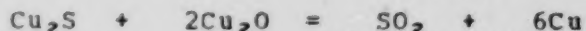
WHEN 3.60 MOLES OF NO₂ AND 21.46 G OF H₂O ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF HNO₃ CAN BE EXPECTED?

3.



WHAT WEIGHT OF H₂O IS THE THEORETICAL YIELD FROM 9.55 G OF H₂ AND 5.29 MOLES OF Fe₂O₃?

4.



HOW MANY MOLES OF Cu CAN BE FORMED FROM 59.70 G OF Cu₂S?

5.



IN AN EXPERIMENT, 2.38 MOLES OF NH₃ ARE TREATED WITH EXCESS O₂. THE NO OBTAINED WEIGHED 45.34 G. WHAT WAS THE PERCENT YIELD?

6.



HOW MANY GRAMS OF C WAS REQUIRED TO MAKE 6.00 G OF CaC₂ IF THE YIELD WAS 11.9%?

Problem Set 9

1.



WHEN 2.49 MOLES OF H_2 AND 8.40 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_2O CAN BE EXPECTED?

2.



HOW MANY GRAMS OF C ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 1.74 MOLES OF CaC_2 , IF THE REACTION HAS A YIELD OF 11.7 % ?

3.



CALCULATE THE NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED BY 0.83 MOLES OF H_2O .

4.



STARTING WITH 24.75 G OF $\text{C}_3\text{H}_8\text{O}$ AND 38.33 G OF O_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H_2O WHICH CAN BE PRODUCED ?

5.



A STUDENT REACTS 8.00 G OF H_3PO_4 WITH 63.00 G OF $\text{Ba}(\text{OH})_2$. IF THE STUDENT ACTUALLY OBTAINS 21.13 G OF $\text{Ba}_3(\text{PO}_4)_2$, WHAT IS THE PERCENT YIELD?

6.



WHAT WEIGHT OF CO_2 IS THE THEORETICAL YIELD FROM 46.00 G OF $\text{C}_3\text{H}_8\text{O}$ AND 0.98 MOLES OF O_2 ?

Problem Set 10

1.



Fe WAS PREPARED BY TREATING 49.00 G OF H_2 WITH EXCESS Fe_2O_3 . THE Fe COLLECTED WEIGHED 217.67 G. WHAT WAS THE PERCENT YIELD?

2.



HOW MANY GRAMS OF H_2 WAS REQUIRED TO MAKE 50.00 G OF HF IF THE YIELD WAS 98.2%?

3.



WHEN 4.36 MOLES OF NO_2 AND 6.70 G OF H_2O ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF HNO_3 CAN BE EXPECTED?

4.



HOW MANY GRAMS OF Fe IS THEORETICALLY OBTAINABLE FROM 3.156 G OF 52.298 % PURE H_2 ?

5.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF H_2O EXPECTED WHEN 28.80 G OF C_6H_6 REACTS WITH 38.55 G OF O_2 ?

6.



STARTING WITH 54.25 G OF XeF_4 AND 7.12 G OF H_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF HF WHICH CAN BE PRODUCED?

Problem Set 11

1.



WHAT WEIGHT OF SO_2 IS THE THEORETICAL YIELD FROM 33.25 G OF Cu_2S AND 4.39 MOLES OF Cu_2O ?

2.



A STUDENT REACTS 42.00 G OF NO_2 WITH 52.00 G OF H_2O . IF THE STUDENT ACTUALLY OBTAINS 4.43 G OF NO , WHAT IS THE PERCENT YIELD?

3.



IN THIS REACTION, 36.00 G OF H_2 AND 35.00 G OF Fe_2O_3 RESULTS IN AN ACTUAL YIELD OF 84.9 %. HOW MANY GRAMS OF Fe ARE OBTAINED ?

4.



A STUDENT TAKES 95.90 G OF XeF_4 AND REACTS IT WITH 0.58 MOLES OF H_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF Xe THAT COULD BE FORMED IN THIS EXPERIMENT ?

5.



CALCULATE THE NUMBER OF GRAMS OF $\text{Ba}_3(\text{PO}_4)_2$ WHICH CAN BE PRODUCED BY 3.47 MOLES OF $\text{Ba}(\text{OH})_2$.

6.



IF WE START WITH 30.40 G OF ZnS AND 13.18 G OF O_2 , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF ZnO WILL IT PRODUCE ?

Problem Set 12

1.



CO_2 WAS PREPARED BY TREATING 21.00 G OF C_6H_6 WITH EXCESS O_2 . THE CO_2 COLLECTED WEIGHED 57.71 G. WHAT WAS THE PERCENT YIELD ?

2.



HOW MANY GRAMS OF PBr_3 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 1.78 MOLES OF H_3PO_3 , IF THE REACTION HAS A YIELD OF 88.9 % ?

3.



WHEN 0.79 MOLES OF XeF_4 AND 12.38 G OF H_2 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF HF CAN BE EXPECTED?

4.



CALCULATE THE NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED BY 3.24 MOLES OF H_2O .

5.



WHAT WEIGHT OF NO IS THE THEORETICAL YIELD FROM 14.60 G OF NH_3 AND 3.95 MOLES OF O_2 ?

6.



STARTING WITH 44.15 G OF H_3PO_4 AND 11.14 G OF $\text{Ba}(\text{OH})_2$, WHAT IS THE MAXIMUM NUMBER OF GRAMS OF $\text{Ba}_3(\text{PO}_4)_2$ WHICH CAN BE PRODUCED ?

Problem Set 13

1.



HOW MANY MOLES OF PbCl_2 CAN WE EXPECT FROM A REACTION BETWEEN 5.03 MOLES OF PCl_3 AND 4.90 MOLES OF PbF_2 ?

2.



$\text{Ba}_3(\text{PO}_4)_2$ WAS PREPARED BY TREATING 13.00 G OF H_3PO_4 WITH EXCESS $\text{Ba}(\text{OH})_2$. THE $\text{Ba}_3(\text{PO}_4)_2$ COLLECTED WEIGHED 37.25 G. WHAT WAS THE PERCENT YIELD?

3.



IN THIS REACTION, 28.00 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 78.00 G OF PBr_3 RESULTS IN AN ACTUAL YIELD OF 49.8 %. HOW MANY GRAMS OF $\text{C}_2\text{H}_5\text{Br}$ ARE OBTAINED?

4.



CALCULATE THE NUMBER OF GRAMS OF CO WHICH CAN BE PRODUCED BY 3.94 MOLES OF C .

5.



WHEN 1.07 MOLES OF ZnS AND 43.64 G OF O_2 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF SO_2 CAN BE EXPECTED?

6.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF Fe EXPECTED WHEN 43.00 G OF H_2 REACTS WITH 36.55 G OF Fe_2O_3 ?

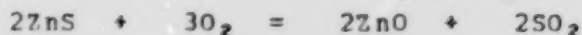
Problem Set 14

1.



WHEN 1.57 MOLES OF $\text{C}_2\text{H}_5\text{OH}$ AND 30.44 G OF PBr_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_3PO_3 CAN BE EXPECTED?

2.



WHAT WEIGHT OF SO_2 IS THE THEORETICAL YIELD FROM 28.90 G OF ZnS AND 4.12 MOLES OF O_2 ?

3.



IN THIS REACTION, 31.00 G OF NO_2 AND 75.00 G OF H_2O RESULTS IN AN ACTUAL YIELD OF 49.4 %. HOW MANY GRAMS OF NO ARE OBTAINED?

4.



STARTING WITH 27.20 G OF NO_2 AND 30.88 G OF H_2O , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF HNO_3 WHICH CAN BE PRODUCED?

5.



HOW MANY MOLES OF CO_2 CAN BE FORMED BY THE REACTION OF 1.87 MOLES OF $\text{C}_3\text{H}_8\text{O}$ WITH O_2 IF THE LATTER IS IN EXCESS?

6.



IN AN EXPERIMENT, 0.65 MOLES OF C_6H_6 ARE TREATED WITH EXCESS O_2 . THE CO_2 OBTAINED WEIGHED 15.44 G. WHAT WAS THE PERCENT YIELD?

Problem Set 15

1.



WHEN 2.77 MOLES OF H_2 AND 43.05 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_2O CAN BE EXPECTED?

2.



HOW MANY MOLES OF H_2O CAN WE EXPECT FROM A REACTION BETWEEN 1.41 MOLES OF H_3PO_4 AND 3.62 MOLES OF $\text{Ba}(\text{OH})_2$?

3.



IN THIS REACTION, 5.00 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 42.00 G OF PBr_3 RESULTS IN AN ACTUAL YIELD OF 34.5 %. HOW MANY GRAMS OF H_3PO_3 ARE OBTAINED ?

4.



HOW MANY MOLES OF H_2O CAN BE FORMED FROM 79.30 G OF C_6H_6 ?

5.



ZnO WAS PREPARED BY TREATING 11.00 G OF ZnS WITH EXCESS O_2 . THE ZnO COLLECTED WEIGHED 2.90 G. WHAT WAS THE PERCENT YIELD ?

6.



WHAT WEIGHT OF H_3PO_3 IS THE THEORETICAL YIELD FROM 9.30 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 4.48 MOLES OF PBr_3 ?

Problem Set 16

1.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF CO_2 EXPECTED WHEN 15.90 G OF $\text{C}_3\text{H}_8\text{O}$ REACTS WITH 9.54 G OF O_2 ?

2.



WHEN 1.46 MOLES OF ZnS AND 28.34 G OF O_2 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF ZnO CAN BE EXPECTED?

3.



STARTING WITH 39.65 G OF NO_2 AND 23.12 G OF H_2O , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED ?

4.



IN THIS REACTION, 53.00 G OF XeF_4 AND 42.00 G OF H_2 RESULTS IN AN ACTUAL YIELD OF 95.0 %. HOW MANY GRAMS OF Xe ARE OBTAINED ?

5.



A STUDENT REACTS 22.00 G OF PCl_3 WITH 72.00 G OF PbF_2 . IF THE STUDENT ACTUALLY OBTAINS 2.30 G OF PF_3 , WHAT IS THE PERCENT YIELD?

6.



HOW MANY GRAMS OF H_2O IS THEORETICALLY OBTAINABLE FROM 10.094 G OF 51.199 % PURE Fe_2O_3 ?

Problem Set 17

1.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF Xe EXPECTED WHEN 46.50 G OF XeF_4 REACTS WITH 33.63 G OF H_2 ?

2.



IF WE START WITH 26.25 G OF H_2 AND 13.17 G OF Fe_2O_3 , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF H_2O WILL IT PRODUCE ?

3.



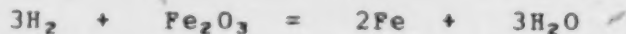
A STUDENT REACTS 32.00 G OF XeF_4 WITH 35.00 G OF H_2 . IF THE STUDENT ACTUALLY OBTAINS 3.14 G OF Xe, WHAT IS THE PERCENT YIELD?

4.



A STUDENT TAKES 33.70 G OF NO_2 AND REACTS IT WITH 5.22 MOLES OF H_2O . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF HNO_3 THAT COULD BE FORMED IN THIS EXPERIMENT ?

5.



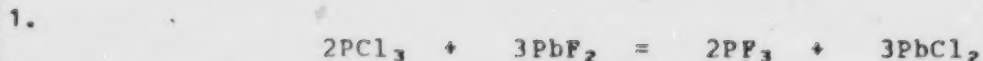
HOW MANY GRAMS OF Fe_2O_3 WAS REQUIRED TO MAKE 24.00 G OF H_2O IF THE YIELD WAS 44.3% ?

6.



HOW MANY MOLES OF Xe CAN BE FORMED BY THE REACTION OF 1.45 MOLES OF XeF_4 WITH H_2 IF THE LATTER IS IN EXCESS?

Problem Set 18



STARTING WITH 37.90 G OF PCl_3 AND 52.53 G OF PbF_2 ,
WHAT IS THE MAXIMUM NUMBER OF GRAMS OF PbCl_2 WHICH CAN BE PRODUCED ?



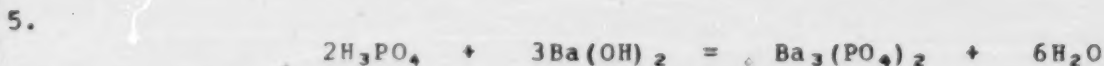
HOW MANY GRAMS OF CaO WAS REQUIRED TO MAKE 42.00 G OF
 CaC_2 IF THE YIELD WAS 24.9% ?



HOW MANY MOLES OF CO_2 CAN BE FORMED FROM 18.70 G OF
 C_6H_6 ?



WHAT WEIGHT OF H_2O IS THE THEORETICAL YIELD FROM
32.45 G OF $\text{C}_3\text{H}_8\text{O}$ AND 2.13 MOLES OF O_2 ?



WHEN 1.77 MOLES OF H_3PO_4 AND 17.26 G OF $\text{Ba}(\text{OH})_2$ ARE MADE TO REACT, WHICH
ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_2O CAN BE EXPECTED?



A STUDENT REACTS 50.00 G OF XeF_4 WITH 70.00 G OF
 H_2 . IF THE STUDENT ACTUALLY OBTAINS 11.91 G OF
 Xe , WHAT IS THE PERCENT YIELD?

Problem Set 19

1.



CALCULATE THE NUMBER OF GRAMS OF PbCl_2 WHICH CAN BE PRODUCED BY 1.05 MOLES OF PbF_2 .

2.



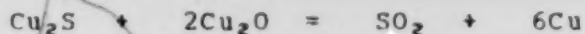
HOW MANY GRAMS OF O_2 WAS REQUIRED TO MAKE 29.00 G OF NO IF THE YIELD WAS 75.3% ?

3.



IF WE START WITH 29.85 G OF NO_2 AND 32.72 G OF H_2O , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF NO WILL IT PRODUCE ?

4.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF SO_2 EXPECTED WHEN 48.90 G OF Cu_2S REACTS WITH 25.14 G OF Cu_2O ?

5.



IF WE START WITH 36.00 G OF Cu_2S AND 1.61 MOLES OF Cu_2O IN THIS REACTION, AND 11.85 G OF SO_2 ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

6.



A STUDENT TAKES 63.50 G OF ZnS AND REACTS IT WITH 1.06 MOLES OF O_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF SO_2 THAT COULD BE FORMED IN THIS EXPERIMENT ?

Problem Set 20

1.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF CO_2 EXPECTED WHEN 11.05 G OF C_6H_6 REACTS WITH 24.43 G OF O_2 ?

2.



WHEN 1.72 MOLES OF H_2 AND 17.34 G OF Fe_2O_3 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF Fe CAN BE EXPECTED?

3.



IN AN EXPERIMENT, 4.14 MOLES OF NH_3 ARE TREATED WITH EXCESS O_2 . THE NO OBTAINED WEIGHED 68.31 G. WHAT WAS THE PERCENT YIELD ?

4.



HOW MANY GRAMS OF H_2 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 1.62 MOLES OF Fe, IF THE REACTION HAS A YIELD OF 13.4 % ?

5.



HOW MANY MOLES OF CO CAN WE EXPECT FROM A REACTION BETWEEN 1.79 MOLES OF CaO AND 2.57 MOLES OF C?

6.



HOW MANY MOLES OF H_2O CAN BE FORMED BY THE REACTION OF 2.38 MOLES OF H_2 WITH Fe_2O_3 IF THE LATTER IS IN EXCESS?

The CM Project

The Computer-enriched Module (CM) project is a collaborative effort by 19 faculty members in the disciplines of chemistry, mathematics and physics, to produce self-instructional computer-based materials at the introductory college level in those disciplines. Each module is designed to be usable in an academic environment with minimal computational facilities, and by students and faculty who are not programming experts. It may be used as an adjunct to standard textual materials, or in many cases, as a replacement for them. The primary aim of each module is to use the computer in such a way that students may take a more active role in the development and discovery of concepts and phenomena.

CM Project Staff

Chemistry

C. J. Jameson
Chem. Group Leader
U. of Ill. - CC
Chicago, IL

M. Bader
Moravian College
Bethlehem, PA

A. K. Jameson
Loyola University
Chicago, IL

J. Manock
Western Carolina U.
Cullowhee, NC

R. T. O'Neill
Xavier University
Cincinnati, OH

F. A. Settle, Jr.
Va. Military Inst.
Lexington, VA

R. Williams
(formerly) U. of Neb.
Lincoln, NB

Mathematics

J. H. Mayne
Math. Group Leader
Loyola University
Chicago, IL

R. A. Alo
Carnegie-Mellon U.
Pittsburgh, PA

N. C. Harbertson
Cal. St. Univ.
Fresno, CA

L. C. Leinbach
Gettysburg College
Gettysburg, PA

J. C. Mathews
Iowa State Univ.
Ames, IA

L. E. Mauland
U. of North Dakota
Grand Forks, ND

Physics

H. Weinstock
Phys. Group Leader
IIT
Chicago, IL

D. Davidson
Pima Comm. Coll.
Tucson, AR

P. Goldstein
Jersey City St. C.
Jersey City, NJ

W. Lang
MacMurray College
Jacksonville, IL

L. E. Turner, Jr.
Pacific Union Coll.
Angwin, CA

S. L. Wiley
Cal. State Univ.
Dominguez Hills, CA

Address all correspondence to

Professor H. Weinstock
Director, CM Project
Physics Department
Illinois Institute of Technology
Chicago, Illinois 60616

TEACHER'S GUIDE TO
A MODULE ON STOICHIOMETRY
UNIT 2. SOLVING STOICHIOMETRY PROBLEMS

ROBERT C. WILLIAMS
UNIVERSITY OF NEBRASKA

a computer-enriched module
for introductory chemistry
featuring the programs

ST01

ST02

Supported by grants from the
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TEACHER'S GUIDE TO THE UNIT ON SOLVING STOICHIOMETRY PROBLEMS OF THE STOICHIOMETRY MODULE

EDUCATIONAL OBJECTIVES

The purpose of this module is to introduce the student to the solution map approach to the solution of stoichiometry problems. For this purpose, examples and drill problems on interconversion of numbers of atoms or molecules and weights of materials are provided on introductory material. Following this, more complex problems employing interconversion of different chemical species are employed to give the student practice in actual stoichiometry calculations. Finally, the concepts of limiting reagent and percent yields are introduced and both drill problems and examples provided. Twenty problem sets are included with the module. The answers to those problems are included in this teacher's guide.

IMPLEMENTATION

The unit fits in early in the first semester of the Freshman sequence. The total time for terminal use should be relatively small (only a few minutes per student) since the BASIC programs ST01 and ST02 included in this guide each generate unique exams of 5 questions for each student. It is intended that he or she take the exam away, solve the problems, and then return to the terminal for checking of the answers. The program makes extensive use of the RND function of BASIC to insure individual exams are different. Most of the types of problems included are the very simplest stoichiometry problems, which do not involve the concept of limiting reagent or percentage yield. For problems of the latter type, any 1 or 2 of the problem sets should be assigned.

ANSWERS TO PROBLEM SETS

TEST 1	TEST 2	TEST 3	TEST 4
1. $9.50\text{E}+00$	1. $7.26\text{E}+01$	1. $8.97\text{E}+01$	1. PBr_3 $4.19\text{E}+00$
2. Fe_2O_3 $2.09\text{E}+01$	2. $1.50\text{E}+01$	2. Fe_2O_3 $3.33\text{E}+01$	2. $1.59\text{E}+01$
3. $4.87\text{E}+01 \text{ G}$	3. O_2 $5.06\text{E}+01$	3. $2.97\text{E}+00$	3. $1.17\text{E}+01$
4. $8.72\text{E}-01$	4. $2.93\text{E}+00$	4. $2.84\text{E}+00$	4. $9.06\text{E}-01$
5. $2.59\text{E}+00$	5. $4.56\text{E}+00 \text{ G}$	5. $2.20\text{E}+01 \text{ G}$	5. $2.82\text{E}+02 \text{ G}$
6. $1.45\text{E}+02$	6. $3.21\text{E}+00$	6. $4.61\text{E}+00$	6. $9.72\text{E}+01$

TEST 5	TEST 6	TEST 7	TEST 8
1. 1.92E+00	1. 5.67E+01	1. 5.14E+00	1. 5.43E+01
2. 6.07E+00	2. 3.26E+01	2. 9.04E+01	2. ^{H₂O} 1.50E+02
3. ^{Ba(OH)₂} 5.39E-01	3. ^{Fe₂O₃} 3.53E+00	3. 4.75E+01	3. 8.59E+01 G
4. 1.31E+01 G	4. 2.01E+00	4. ^{PbF₂} 4.29E-02	4. 2.25E+00
5. 4.66E+01	5. 2.79E+01	5. 3.91E+01	5. 6.35E+01
6. 1.14E+01	6. 4.20E-01	6. 9.93E+01	6. 2.83E+01

TEST 9	TEST 10	TEST 11	TEST 12
Fe_2O_3 1. $2.83\text{E}+00$ 2. $5.36\text{E}+02$ 3. $2.50\text{E}+01$ 4. $1.92\text{E}+01$ 5. $8.60\text{E}+01$ 6. $2.87\text{E}+01 \text{ G}$	1. $2.38\text{E}+01$ 2. $2.55\text{E}+00$ 3. H_2O $4.69\text{E}+01$ 4. $3.08\text{E}+01$ 5. $8.67\text{E}+00$ 6. $2.09\text{E}+01$	1. $1.34\text{E}+01 \text{ G}$ 2. $4.85\text{E}+01$ 3. $2.08\text{E}+01$ 4. $3.81\text{E}+01$ 5. $6.97\text{E}+02$ 6. O_2 $2.75\text{E}-01$	1. $8.12\text{E}+01$ 2. $5.42\text{E}+02$ 3. XeF_4 $6.32\text{E}+01$ 4. $9.73\text{E}+01$ 5. $2.58\text{E}+01 \text{ G}$ 6. $1.30\text{E}+01$

TEST 13	TEST 14	TEST 15	TEST 16
1. 4.90E+00	PBr ₃ 1. 9.22E+00	Fe ₂ O ₃ 1. 1.45E+01	1. 8.74E+00
2. 9.33E+01	2. 1.90E+01 G	2. 4.23E+00	2. ^{O₂} ~~4.80~~ E+01
3. 3.30E+01	3. 3.33E+00	3. 1.02E+00	3. 8.62E+00
4. 3.68E+01	4. 2.48E+01	4. 3.05E+00	4. 3.19E+01
^{O₂} 5. 5.82E+01	5. 5.62E+00	5. 3.16E+01	5. 1.63E+01
6. 2.56E+01	6. 9.00E+00	6. 5.53E+00 G	6. 1.74E+00

TEST 17	TEST 18	TEST 19	TEST 20
1. 2.95E+01	1. 5.96E+01	1. 2.92E+02	1. 2.69E+01
2. Fe_2O_3 2. 2.47E-01	2. 1.48E+02	2. 5.14E+01	2. Fe_2O_3 2. 1.21E+01
3. 1.55E+01	3. 1.44E+00	3. NO_2 2. 2.16E-01	3. 5.50E+01
4. 3.08E+01	4. 3.41E+01 G	4. 5.62E+00	4. 3.63E+01
5. 1.61E+02	5. $\text{Ba}(\text{OH})_2$ 3. 3.63E+00	5. 8.18E+01	5. 8.57E-01
6. 1.45E+00	6. 3.76E+01	6. 4.17E+01	6. 2.38E+00

SOFTWARE

The programs ST01 and ST02 use a random number generator which is included in the programs, since random number generating functions may vary from one computer to another. The same series of random real numbers are generated for the same initial seed. The seed used in printing a quiz is printed out as the exam number. This same number, when typed in by a student requesting grading of his answers to the quiz, regenerates the same series of random numbers. Thus, the problems in the quiz are regenerated and grading of the student's answers is possible.

Sample run of ST01

PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
75764

O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?1

EXAM NUMBER 12083

STEVE

THERE ARE 5 QUESTIONS ON THIS EXAM.
THEY ARE ALL CHEMICAL STOICHIOMETRY PROBLEMS.
PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK
WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED.

QUESTION. 1
HOW MANY GRAMS OF CO₂ CAN BE OBTAINED FROM 5.60002E+24
ATOMS OF CARBON?

QUESTION. 2
HOW MANY ATOMS OF PHOSPHORUS ARE THERE IN 7.6952
GRAMS OF H₃PO₄?

QUESTION. 3
HOW MANY GRAMS OF HCL CAN BE MADE FROM 38
MOLES OF CHLORINE, CL₂?

QUESTION. 4
HOW MANY GRAMS OF H₃PO₄ CAN BE THEORETICALLY OBTAINED FROM 3.05437E+24
ATOMS OF P ?

QUESTION. 5
HOW MANY MOLECULES OF BENZENE, C₆H₆, ARE
THEORETICALLY OBTAINABLE FROM 3 GRAMS OF CARBON?

GOOD LUCK STEVE, AND HURRY BACK.

PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.

?1

O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.

?2

PLEASE ENTER YOUR EXAM NUMBER.

?12083

PLEASE ENTER YOUR 5 ANSWERS IN THE EXACT ORDER OF THE QUESTIONS.
PRESS (RETURN) AFTER EACH ANSWER.

?409.302

?4.72E22

?2736

?496.512

?2.51E22

EXAM NUMBER 12083

STEVE

CORRECT ANSWER	YOUR ANSWER	RESULT
409.201	409.301	CORRECT
4.72942E+22	4.72001E+22	CORRECT
2774.61	2736	CORRECT
491.884	496.512	CORRECT
2.50729E+22	2.51000E+22	CORRECT

YOUR GRADE ON THIS QUIZ IS 100 %

MARVELOUS FRIEND, YOU HAVE BEATEN THIS BROKEN MACHINE.
WOULD YOU LIKE TO TAKE ANOTHER QUIZ?
ENTER 1 FOR YES, 2 FOR NO.

?2

GOOD LUCK STEVE, AND HURRY BACK.

Sample run of ST02

RUN

PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.
?9999

O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.
?1

EXAM NUMBER 30859

STEVE

THERE ARE 5 QUESTIONS ON THIS EXAM.
THEY ARE ALL CHEMICAL STOICHIOMETRY PROBLEMS.
PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK
WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED.

QUESTION. 1
HOW MANY GRAMS OF NABR CAN BE OBTAINED FROM 64
GRAMS OF C6H5BR ?

QUESTION. 2
HOW MANY MOLECULES OF ZNO ARE THEORETICALLY OBTAINABLE FROM
33.5 GRAMS OF ZNS ?

QUESTION. 3
HOW MANY GRAMS OF WATER ARE THEORETICALLY OBTAINABLE FROM
56 GRAMS OF OXYGEN (GAS) ?

QUESTION. 4
HOW MANY GRAMS OF ETHANE CAN BE MADE FROM 1.51200×10^{26}
MOLECULES OF H2O ?

QUESTION. 5
HOW MANY GRAMS OF CH3COOH CAN BE OBTAINED FROM 28
GRAMS OF O2 AND 75 GRAMS OF C2H5OH ?

GOOD LUCK STEVE, AND HURRY BACK.

READY

RUN

PLEASE TYPE IN YOUR NAME
STEVE

STEVE PLEASE INPUT A NUMBER FROM 1 THRU 15,000.

?1

O.K. STEVE, DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?
IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO
HAVE AN EXAM GRADED, ENTER A 2.

?2

PLEASE ENTER YOUR EXAM NUMBER.

?30859

PLEASE ENTER YOUR 5 ANSWERS IN THE EXACT ORDER OF THE QUESTIONS.
PRESS (RETURN) AFTER EACH ANSWER.

?41.95

?1.72E23

?3.5

?2491

?52.55

EXAM NUMBER 30859

STEVE

CORRECT ANSWER	YOUR ANSWER	RESULT
41.9449	41.9499	CORRECT
2.06986E+23	1.72000E+23	WRONG
63.0559	3.5	WRONG
2516.23	2491	CORRECT
52.5472	52.5499	CORRECT

YOUR GRADE ON THIS QUIZ IS 60 %

WOULD YOU LIKE TO TAKE ANOTHER QUIZ?
ENTER 1 FOR YES, 2 FOR NO.

?2

GOOD LUCK STEVE, AND HURRY BACK.

READY

\LIST

```

10 REM *****
20 REM ***
30 REM ***      PROGRAM STO1
40 REM ***
50 REM ***  THIS IS A TWO PASS PROGRAM IN WHICH PROBLEMS WILL BE
60 REM ***  SELECTED AT RANDOM.  AFTER ANSWERING THE QUESTIONS
70 REM ***  THE STUDENT WILL RETURN AND SUBMIT HIS ANSWERS.  THE
80 REM ***  COMPUTER WILL THEN GRADE HIS RESULTS
90 REM ***
100 REM *****
110 DIM B(5),C(5),A$(20)
120 LET K=G=0
130 PRINT
140 PRINT
150 PRINT "PLEASE TYPE IN YOUR NAME"
160 INPUT A$
170 PRINT
180 PRINT A$;
190 PRINT " PLEASE INPUT A NUMBER FROM 1 THRU 15,000."
200 INPUT S
210 IF S<1 THEN 190
220 IF S>15000 THEN 190
230 PRINT "O.K. ";
240 PRINT A$;
250 PRINT ", DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?"
260 PRINT "IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO"
270 PRINT "HAVE AN EXAM GRADED, ENTER A 2."
280 LET P=1
290 INPUT Y
300 IF Y=1 THEN 470
310 LET K=K+1
320 IF Y=2 THEN 360
330 IF K>3 THEN 2670
340 PRINT "PLEASE ENTER 1 OR 2!"
350 GOTO 260
360 PRINT "PLEASE ENTER YOUR EXAM NUMBER."
370 INPUT X
380 PRINT &
    "PLEASE ENTER YOUR 5 ANSWERS IN THE EXACT ORDER OF THE QUESTIONS."
390 PRINT "PRESS (RETURN) AFTER EACH ANSWER."
400 FOR U=1 TO 5
410   INPUT C(U)
420 NEXT U
430 LET S=X
440 LET R=X
450 LET P=2
460 GOTO 510
470 GOSUB 2390
480 LET S=R1
490 LET R=INT(10000.5+22000*R2)
500 LET S=R

```

```

510 PRINT
520 PRINT
530 PRINT &
-----
540 PRINT
550 PRINT "EXAM NUMBER";R
560 PRINT
570 PRINT A$;
580 PRINT
590 PRINT
600 IF P<>1 THEN 650
610 PRINT "THERE ARE 5 QUESTIONS ON THIS EXAM."
620 PRINT "THEY ARE ALL CHEMICAL STOICHIOMETRY PROBLEMS."
630 PRINT "PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK"
640 PRINT "WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED."
650 PRINT
660 PRINT
670 LET I=0
680 GOSUB 2390
690 LET R3=(INT(20+60*R2)/10)*1E24
700 GOSUB 2390
710 LET R=INT(1.5+3*R2)
720 GOSUB 2610
730 IF P<>1 THEN 750
740 PRINT "HOW MANY GRAMS OF ";
750 GOTO R OF 760,810,860,910
760 IF P<>1 THEN 790
770 PRINT "CO2 CAN BE OBTAINED FROM";R3
780 PRINT "ATOMS OF CARBON?"
790 LET B(I)=(R3/6.02301E23)*44.011
800 GOTO 950
810 IF P<>1 THEN 840
820 PRINT "OXYGEN CAN BE OBTAINED FROM";R3
830 PRINT "MOLECULES OF C2H5OH?"
840 LET B(I)=(R3/6.02301E23)*16
850 GOTO 950
860 IF P<>1 THEN 890
870 PRINT "CALCIUM CAN BE OBTAINED FROM";R3
880 PRINT "MOLECULES OF CaO?"
890 LET B(I)=(R3/6.02301E23)*40.0799
900 GOTO 950
910 IF P<>1 THEN 940
920 PRINT "CARBON CAN BE OBTAINED FROM";R3
930 PRINT "MOLECULES OF BENZENE, C6H6?"
940 LET B(I)=(R3/6.02301E23)*12.011*6
950 GOSUB 2390
960 LET R3=(20+85*R2)/10
970 GOSUB 2390
980 LET R=INT(1.5+3*R2)
990 GOSUB 2610
1000 IF P<>1 THEN 1020
1010 PRINT "HOW MANY ";
1020 GOTO R OF 1030,1080,1130,1180

```

```

1030 IF P<>1 THEN 1060
1040 PRINT "ATOMS OF FLUORINE CAN BE OBTAINED FROM";R3
1050 PRINT "GRAMS OF SODIUM FLUORIDE, NAF?"
1060 LET B(I)=6.02301E23*(R3/(19+22.9909))
1070 GOTO 1220
1080 IF P<>1 THEN 1110
1090 PRINT "ATOMS OF SULFUR ARE THERE IN";R3
1100 PRINT "GRAMS OF SULFURIC ACID, H2SO4?"
1110 LET B(I)=6.02301E23*(R3/98.086)
1120 GOTO 1220
1130 IF P<>1 THEN 1160
1140 PRINT "ATOMS OF PHOSPHORUS ARE THERE IN";R3
1150 PRINT "GRAMS OF H3PO4?"
1160 LET B(I)=6.02301E23*(R3/98)
1170 GOTO 1220
1180 IF P<>1 THEN 1210
1190 PRINT "MOLECULES OF BROMINE ARE THERE IN";R3
1200 PRINT "GRAMS OF C2H5BR?"
1210 LET B(I)=6.02301E23*.5*(R3/108.979)
1220 GOSUB 2390
1230 LET R3=INT(10+50*R2)
1240 GOSUB 2390
1250 LET R=INT(1.5+3*R2)
1260 GOSUB 2610
:270 IF P<>1 THEN 1290
1280 PRINT "HOW MANY ";
1290 GOTO R OF 1300,1350,1400,1450
1300 IF P<>1 THEN 1330
1310 PRINT "ATOMS OF CARBON ARE THERE IN";R3
1320 PRINT "GRAMS OF CARBON DIOXIDE, CO2?"
1330 LET B(I)=(R3/44.011)*6.02301E23
1340 GOTO 1490
1350 IF P<>1 THEN 1380
1360 PRINT "MOLES OF CHLORINE GAS, CL2, CAN BE MADE FROM";R3
1370 PRINT "GRAMS OF HCL?"
1380 LET B(I)=(R3/(1.008+35.5))*5
1390 GOTO 1490
1400 IF P<>1 THEN 1430
1410 PRINT "GRAMS OF HCL CAN BE MADE FROM";R3
1420 PRINT "MOLES OF CHLORINE, CL2?"
1430 LET B(I)=2*R3*(1.008+35.5)
1440 GOTO 1490
1450 IF P<>1 THEN 1480
1460 PRINT "MOLECULES OF ETHYL ALCOHOL, C2H5OH, CAN BE MADE FROM";R3
1470 PRINT "GRAMS OF OXYGEN, O2?"
1480 LET B(I)=(R3/32)*2*6.02301E23
1490 GOSUB 2390
1500 LET R3=(1.69999+30*R2)*6.02301E23
1510 GOSUB 2390
1520 LET R=INT(1.5+3*R2)
1530 GOSUB 2610
1540 IF P<>1 THEN 1560
1550 PRINT "HOW MANY GRAMS OF ";

```

```

1560 GOTO R OF 1570,1620,1660,1710
1570 IF P<>1 THEN 1600
1580 PRINT "SODIUM FLUORIDE, NAF, CAN BE MADE FROM";R3
1590 PRINT "MOLECULES OF FLUORINE, F2?"
1600 LET B(1)=(R3/6.02301E23)*(22.9899+19)*2
1610 GOTO 1750
1620 IF P<>1 THEN 1640
1625 PRINT "2S04 CAN BE OBTAINED FROM";R3
1630 PRINT "ATOMS OF S?"
1640 LET B(1)=(R3/6.02301E23)*(2*1.008+16*4+32.01)
1650 GOTO 1750
1660 IF P<>1 THEN 1690
1670 PRINT "H3P04 CAN BE THEORETICALLY OBTAINED FROM";R3
1680 PRINT "ATOMS OF P?"
1690 LET B(1)=(R3/6.02301E23)*(2*1.008+16*4+30.9799)
1700 GOTO 1750
1710 IF P<>1 THEN 1740
1720 PRINT "METHANE, CH4, CAN BE MADE FROM";R3
1730 PRINT "MOLECULES OF HYDROGEN?"
1740 LET B(1)=(R3/(2*1.008))*5*(12.011+4*1.008)
1750 GOSUB 2390
1760 LET R3=(INT(15+49*R2))/10
1770 GOSUB 2390
1780 LET R=INT(1.5+3*R2)
1790 GOSUB 2610
1800 IF P<>1 THEN 1820
1810 PRINT "HOW MANY ";
1820 GOTO R OF 1830,1880,1930,1990
1830 IF P<>1 THEN 1860
1840 PRINT "MOLECULES OF CA0 CAN BE MADE FROM";R3
1850 PRINT "GRAMS OF CALCIUM?"
1860 LET B(1)=(R3/40.0799)*6.02301E23
1870 GOTO 2030
1880 IF P<>1 THEN 1910
1890 PRINT "MOLECULES OF BENZENE, C6H6, ARE"
1900 PRINT "THEORETICALLY OBTAINABLE FROM";R3;"GRAMS OF CARBON?"
1910 LET B(1)=(R3/12.011)*6.02301E23*(1/6)
1920 GOTO 2030
1930 LET R3=R3*4.3E24
1940 IF P<>1 THEN 1970
1950 PRINT "GRAMS OF C2H5BR CAN BE MADE FROM";R3
1960 PRINT "MOLECULES OF BROMINE, BR2?"
1970 LET B(1)=(R3/6.02301E23)*2*(2*12.011+5*1.008+79.9099)
1980 GOTO 2030
1990 IF P<>1 THEN 2020
2000 PRINT "GRAMS OF HYDROGEN, H2, CAN BE OBTAINED FROM";R3
2010 PRINT "GRAMS OF METHANE, CH4?"
2020 LET B(1)=(R3/(12.011+4*1.008))*2*2.016
2030 IF P=1 THEN 2150
2040 PRINT "CORRECT","YOUR"
2050 PRINT "ANSWER","ANSWER","RESULT"
2060 PRINT
2070 FOR I=1 TO 5

```

```

2080 IF B(I)>1.05*C(I) THEN 2130
2090 IF B(I)<.95*C(I) THEN 2130
2100 PRINT B(I),C(I),"CORRECT"
2110 LET G=G+20
2120 GOTO 2140
2130 PRINT B(I),C(I),"WRONG"
2140 NEXT I
2150 PRINT
2160 IF P=1 THEN 2180
2170 PRINT "YOUR GRADE ON THIS QUIZ IS";INT(G);"%"
2180 PRINT
2190 PRINT &
"-----"
2200 IF INT(G)<>100 THEN 2220
2210 PRINT "MARVELOUS FRIEND, YOU HAVE BEATEN THIS BROKEN MACHINE."
2220 IF P<>1 THEN 2270
2230 PRINT "GOOD LUCK ";
2240 PRINT A$
2250 PRINT ", AND HURRY BACK."
2260 PRINT
2270 IF P=1 THEN 2710
2280 IF P=9999 THEN 2710
2290 PRINT "WOULD YOU LIKE TO TAKE ANOTHER QUIZ?"
2300 PRINT "ENTER 1 FOR YES, 2 FOR NO."
2310 INPUT Z
2320 LET P=1
2330 LET G=0
2340 IF Z=1 THEN 470
2350 IF Z=2 THEN 2370
2360 GOTO 2300
2370 LET P=9999
2380 GOTO 2230
2390 REM *****
2400 REM ***
2410 REM *** THIS IS THE RANDOM NUMBER GENERATOR.
2420 REM *** GIVEN A SEED, S, IT PRODUCES A RANDOM INTEGER (R1)
2430 REM *** FROM 1 THRU 16,384 AND A RANDOM REAL NUMBER (R2)
2440 REM *** FROM 0 THRU 1.
2450 REM ***
2460 LET A=131
2470 LET M=16384
2480 REM *** MAKE SURE THE SEED IS ODD
2490 IF (INT(S/2))*2<>S THEN 2510
2500 LET S=INT(S+1)
2510 LET T=A*S
2520 LET Q=INT(T/M)
2530 LET R1=T-Q*M
2540 LET R2=R1/(M-1)
2550 REM *** SET THE SEED TO THE VALUE OF THE RANDOM INTEGER
2560 REM *** JUST GENERATED

```

```
2570 LET S=R1
2580 REM *** THIS INSURES THAT THE SERIES OF RANDOM REAL NUMBERS
2590 REM *** GENERATED FOR THE SAME INITIAL SEED WILL BE IDENTICAL.
2600 RETURN
2610 REM *****
2620 LET I=I+1
2630 IF P=2 THEN 2660
2640 PRINT
2650 PRINT "QUESTION. ";I
2660 RETURN
2670 PRINT "SORRY ";
2680 PRINT ASJ
2690 PRINT ", PLEASE GET SOME HELP. SO LONG FOR NOW."
2700 STOP
2710 END
>
```

>LIST

ST02

```

10 REM *****
20 REM ***
30 REM ***          PROGRAM ST02
40 REM ***
50 REM ***  THIS IS A TWO PASS PROGRAM IN WHICH PROBLEMS WILL BE
60 REM ***  SELECTED AT RANDOM.  AFTER ANSWERING THE QUESTIONS
70 REM ***  THE STUDENT WILL RETURN AND SUBMIT HIS ANSWERS.  THE
80 REM ***  COMPUTER WILL THEN GRADE HIS RESULTS.
90 REM ***
100 REM *****
110 DIM B(5),C(5),A$(25)
120 LET K=G=0
130 PRINT
140 PRINT
150 PRINT "PLEASE TYPE IN YOUR NAME"
160 INPUT A$
170 PRINT
180 PRINT A$;
190 PRINT " PLEASE INPUT A NUMBER FROM 1 THRU 15,000."
200 INPUT S
210 IF S<1 THEN 190
220 IF S>15000 THEN 190
230 PRINT "O.K. ";
240 PRINT A$;
250 PRINT ", DO YOU WISH TO TAKE A TEST OR HAVE YOUR TEST GRADED?"
260 PRINT "IF YOU WISH TO TAKE A TEST, ENTER A 1, AND IF YOU WISH TO"
270 PRINT "HAVE AN EXAM GRADED, ENTER A 2."
280 LET P=1
290 INPUT Y
300 IF Y=1 THEN 470
310 LET K=K+1
320 IF Y=2 THEN 360
330 IF K>3 THEN 3210
340 PRINT "PLEASE ENTER 1 OR 2!"
350 GOTO 260
360 PRINT "PLEASE ENTER YOUR EXAM NUMBER."
370 INPUT X
380 PRINT "PLEASE ENTER YOUR 5 ANSWERS IN THE";
385 PRINT " EXACT ORDER OF THE QUESTIONS."
390 PRINT "PRESS (RETURN) AFTER EACH ANSWER."
400 FOR U=1 TO 5
410   INPUT C(U)
420 NEXT U
430 LET S=X
440 LET R=X
450 LET P=2
460 GOTO 510
470 GOSUB 2930
480 LET S=R1
490 LET R=INT(10000.5+22000*R2)
500 LET S=R
510 PRINT

```

```

520 PRINT
530 PRINT "-----";
540 PRINT "-----"
550 PRINT
560 PRINT "EXAM NUMBER";R
570 PRINT
580 PRINT A$;
590 PRINT
600 PRINT
610 IF P<>1 THEN 660
620 PRINT "THERE ARE 5 QUESTIONS ON THIS EXAM."
630 PRINT "THEY ARE ALL CHEMICAL STOICHIOMETRY PROBLEMS."
640 PRINT "PLEASE ANSWER THE QUESTIONS AT HOME, AND COME BACK"
650 PRINT "WHEN YOU ARE READY TO HAVE YOUR EXAM GRADED."
660 PRINT
670 PRINT
680 LET I=0
690 GOSUB 2930
700 LET R3=INT(20+60*R2)
710 GOSUB 2930
720 LET R=INT(1.5+4*R2)
730 GOSUB 3150
740 IF P<>1 THEN 760
750 PRINT "HOW MANY GRAMS OF ";
760 GOTO R OF 770,820,870,920,970
770 IF P<>1 THEN 800
780 PRINT "KCL04 ARE THEORETICALLY OBTAINABLE FROM"
790 PRINT R3;"GRAMS OF POTASSIUM CHLORIDE, KCL?"
800 LET B[I]=(R3/(39.1+35.5))*(39.1+35.5+4*16)
810 GOTO 1010
820 IF P<>1 THEN 850
830 PRINT "OXYGEN (GAS) ARE THEORETICALLY OBTAINABLE FROM"
840 PRINT R3;"GRAMS OF WATER?"
850 LET B[I]=(R3/18.016)*32*.5
860 GOTO 1010
870 IF P<>1 THEN 900
880 PRINT "NABR CAN BE OBTAINED FROM";R3
890 PRINT "GRAMS OF C6H5BR ?"
900 LET B[I]=(R3/(5*1.008+6*12.011+79.9))*(23+79.9)
910 GOTO 1010
920 IF P<>1 THEN 950
930 PRINT "SO2 CAN BE MADE FROM";R3
940 PRINT "GRAMS OF FES2 ?"
950 LET B[I]=(R3/(55.8499+2*32.1))*(32.1+2*16)*2
960 GOTO 1010
970 IF P<>1 THEN 1000
980 PRINT "CO2 CAN BE THEORETICALLY OBTAINED FROM"
990 PRINT R3;"GRAMS OF METHANE, CH4 ?"
1000 LET B[I]=(R3/(12.011+4*1.008))*(12.011+2*16)
1010 GOSUB 2930
1020 LET R3=INT(243+531*R2)/10
1030 GOSUB 2930
1040 LET R=INT(1.5+4*R2)
1050 GOSUB 3150

```

```

1060 IF P<>1 THEN 1080
1070 PRINT "HOW MANY MOLECULES OF ";
1080 GOTO R OF 1090,1140,1190,1240,1290
1090 IF P<>1 THEN 1120
1100 PRINT "WATER CAN BE MADE FROM";R3
1110 PRINT "GRAMS OF ETHANE, C2H6 ?"
1120 LET B(I)=(R3/(12.011*2+1.008*6))*6.02301E23*3
1130 GOTO 1330
1140 IF P<>1 THEN 1170
1150 PRINT "CAC2 CAN BE THEORETICALLY OBTAINED FROM"
1160 PRINT R3;"GRAMS OF CA0 ?"
1170 LET B(I)=(R3/(40.1+16))*6.02301E23
1180 GOTO 1330
1190 IF P<>1 THEN 1220
1200 PRINT "PF3 CAN BE MADE FROM";R3
1210 PRINT "GRAMS OF PCL3 ?"
1220 LET B(I)=(R3/(30.0799+35.5*3))*6.02301E23
1230 GOTO 1330
1240 IF P<>1 THEN 1270
1250 PRINT "ZN0 ARE THEORETICALLY OBTAINABLE FROM"
1260 PRINT R3;"GRAMS OF ZNS ?"
1270 LET B(I)=(R3/(65.38+32.1))*6.02301E23
1280 GOTO 1330
1290 IF P<>1 THEN 1320
1300 PRINT "XENON (GAS) CAN BE MADE FROM";R3
1310 PRINT "GRAMS OF XEF4 ?"
1320 LET B(I)=(R3/(131.3+4*19))*6.02301E23
1330 GOSUB 2930
1340 LET R3=INT(10+95*R2)
1350 GOSUB 2930
1360 LET R=INT(1.5+4*R2)
1370 GOSUB 3150
1380 IF P<>1 THEN 1400
1390 PRINT "HOW MANY GRAMS OF ";
1400 GOTO R OF 1410,1460,1510,1560,1610
1410 IF P<>1 THEN 1440
1420 PRINT "KCL CAN BE MADE FROM ";R3
1430 PRINT "GRAMS OF KCL04 ?"
1440 LET B(I)=(R3/(39.1+35.5+4*16))*(39.1+35.5)
1450 GOTO 1650
1460 IF P<>1 THEN 1490
1470 PRINT "WATER ARE THEORETICALLY OBTAINABLE FROM"
1480 PRINT R3;"GRAMS OF OXYGEN (GAS) ?"
1490 LET B(I)=(R3/32)*18.016*2
1500 GOTO 1650
1510 IF P<>1 THEN 1540
1520 PRINT "C6H5BR CAN BE OBTAINED FROM";R3
1530 PRINT "GRAMS OF NABR ?"
1540 LET B(I)=(R3/(23+79.9))*(12.011*6+1.008*5+79.9)
1550 GOTO 1650
1560 IF P<>1 THEN 1590
1570 PRINT "FES2 CAN BE MADE FROM";R3
1580 PRINT "GRAMS OF S02 ?"
1590 LET B(I)=(R3/(32.1+16*2))*(55.8499+32.1*2)*.5

```

```

1600 GOTO 1650
1610 IF P<>1 THEN 1640
1620 PRINT "METHANE CAN BE OBTAINED FROM";R3
1630 PRINT "GRAMS OF C32 ?"
1640 LET B(I)=(R3/(12.011+2*16))*(12.011+4*1.008)
1650 GOSUB 2930
1660 LET R3=INT(15+80*R2)*2.1E24
1670 GOSUB 2930
1680 LET R=INT(1.5+4*R2)
1690 GOSUB 3150
1700 IF P<>1 THEN 1720
1710 PRINT "HOW MANY GRAMS OF ";
1720 GOTO R OF 1730,1780,1830,1880,1930
1730 IF P<>1 THEN 1760
1740 PRINT "ETHANE CAN BE MADE FROM";R3
1750 PRINT "MOLECULES OF H20 ?"
1760 LET B(I)=(R3/6.02301E23)*(12.011*2+1.008*6)*(1/3)
1770 GOTO 1970
1780 IF P<>1 THEN 1810
1790 PRINT "CA0 CAN BE THEORETICALLY OBTAINED FROM"
1800 PRINT R3;"MOLECULES OF CAC2 ?"
1810 LET B(I)=(R3/6.02301E23)*(40.1+16)
1820 GOTO 1970
1830 IF P<>1 THEN 1860
1840 PRINT "PCL3 ARE THEORETICALLY OBTAINABLE FROM"
1850 PRINT R3;"MOLECULES OF PF3 ?"
1860 LET B(I)=(R3/6.02301E23)*(30.9799+35.5*3)
1870 GOTO 1970
1880 IF P<>1 THEN 1910
1890 PRINT "ZNS CAN BE MADE FROM";R3
1900 PRINT "MOLECULES OF ZN0 ?"
1910 LET B(I)=(R3/6.02301E23)*(65.38+32.1)
1920 GOTO 1970
1930 IF P<>1 THEN 1960
1940 PRINT "XEF4 ARE THEORETICALLY OBTAINABLE FROM"
1950 PRINT R3;"MOLECULES OF XENON GAS?"
1960 LET B(I)=(R3/6.02301E23)*(131.3+19*4)
1970 GOSUB 2930
1980 LET R3=INT(20+60*R2)
1990 GOSUB 2930
2000 LET R4=INT(20+60*R2)
2010 GOSUB 2930
2020 LET R=INT(1.5+4*R2)
2030 GOSUB 3150
2040 GOTO R OF 2050,2160,2260,2370,2470
2050 IF P<>1 THEN 2090
2060 PRINT "YOU HAVE";R3;"GRAMS OF OXYGEN GAS, AND";R4
2070 PRINT "GRAMS OF METHANE."
2080 PRINT "HOW MANY GRAMS OF H20 CAN YOU MAKE?"
2090 LET R4=R4/(12.011+1.008*4)
2100 LET R3=R3/32
2110 IF R3>2*R4 THEN 2140
2120 LET B(I)=R3*18.016
2130 GOTO 2560

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2140 LET B(I)=R4*2*18.016
2150 GOTO 2560
2160 IF P<>1 THEN 2190
2170 PRINT "HOW MANY GRAMS OF CH3COOH CAN BE OBTAINED FROM";R3
2180 PRINT "GRAMS OF O2 AND";R4;"GRAMS OF C2H5OH ?"
2190 LET R3=R3/32
2200 LET R4=R4/(12.011*2+1.008*6+16)
2210 IF R3>R4 THEN 2250
2220 LET B(I)=R3*(12.011*2+1.008*4+16*2)
2230 GOTO 2560
2240 LET B(I)=R4*(12.011*2+1.008*4+16*2)
2250 GOTO 2560
2260 IF P<>1 THEN 2300
2270 PRINT "IF YOU HAVE";R3;"GRAMS OF SODIUM AND";R4
2280 PRINT "GRAMS OF CHLORINE GAS, HOW MANY GRAMS OF SODIUM CHLORIDE"
2290 PRINT "ARE THEORETICALLY OBTAINABLE?"
2300 LET R3=R3/23
2310 LET R4=R4/(35.5*2)
2320 IF R3>2*R4 THEN 2350
2330 LET B(I)=R3*(23+35.5)
2340 GOTO 2560
2350 LET B(I)=R4*(35.5+23)*2
2360 GOTO 2560
2370 IF P<>1 THEN 2400
2380 PRINT "HOW MANY GRAMS OF SULFURIC ACID, H2SO4, CAN BE MADE"
2390 PRINT "FROM";R3;"GRAMS OF SO3 AND";R4;"GRAMS OF WATER?"
2400 LET R3=R3/(32.1+16*3)
2410 LET R4=R4/(16+2*1.008)
2420 IF R3>R4 THEN 2450
2430 LET B(I)=R3*(1.008*2+32.1+16*4)
2440 GOTO 2560
2450 LET B(I)=R4*(1.008*2+32.1+16*4)
2460 GOTO 2560
2470 IF P<>1 THEN 2500
2480 PRINT "HOW MANY GRAMS OF BR-CH2-CH2-BR ARE ";
2485 PRINT "THEORETICALLY OBTAINABLE"
2490 PRINT "FROM";R3;"GRAMS OF CH2=CH2 AND";R4;"GRAMS OF BR2 ?"
2500 LET R3=R3/(12.011*2+1.008*4)
2510 LET R4=R4/(79.9099*2)
2520 IF R3>R4 THEN 2550
2530 LET B(I)=R3*(12.011*2+1.008*4+79.9099*2)
2540 GOTO 2560
2550 LET B(I)=R4*(12.011*2+1.008*4+79.9099*2)
2560 IF P=1 THEN 2680
2570 PRINT "CORRECT","YOUR"
2580 PRINT "ANSWER","ANSWER","RESULT"
2590 PRINT
2600 FOR I=1 TO 5
2610 IF B(I)>1.05*C(I) THEN 2660
2620 IF B(I)<.95*C(I) THEN 2660
2630 PRINT B(I),C(I),"CORRECT"
2640 LET G=G+20
2650 GOTO 2670
2660 PRINT B(I),C(I),"WRONG"

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```

2670 NEXT I
2680 PRINT
2690 IF P=1 THEN 2710
2700 PRINT "YOUR GRADE ON THIS QUIZ IS";INT(G);"X"
2710 PRINT
2720 PRINT "-----";
2730 PRINT "-----"
2740 IF INT(G)<>100 THEN 2760
2750 PRINT "MARVELOUS FRIEND, YOU HAVE BEATEN THIS BROKEN MACHINE."
2760 IF P<>1 THEN 2810
2770 PRINT "GOOD LUCK ";
2780 PRINT A$;
2790 PRINT ", AND HURRY BACK."
2800 PRINT
2810 IF P=1 THEN 3250
2820 IF P=9999 THEN 3250
2830 PRINT "WOULD YOU LIKE TO TAKE ANOTHER QUIZ?"
2840 PRINT "ENTER 1 FOR YES, 2 FOR NO."
2850 INPUT Z
2860 LET P=1
2870 LET G=0
2880 IF Z=1 THEN 470
2890 IF Z=2 THEN 2910
2900 GOTO 2840
2910 LET P=9999
2920 GOTO 2770
2930 REM *****
2940 REM ***
2950 REM *** THIS IS THE RANDOM NUMBER GENERATOR.
2960 REM *** GIVEN A SEED, S, IT PRODUCES A RANDOM INTEGER (R1)
2970 REM *** FROM 1 THRU 16,384 AND A RANDOM REAL NUMBER (R2)
2980 REM *** FROM 0 THRU 1.
2990 REM ***
3000 LET A=131
3010 LET M=16384
3020 REM *** MAKE SURE THE SEED IS ODD
3030 IF (INT(S/2))*2<>S THEN 3050
3040 LET S=INT(S+1)
3050 LET T=A*S
3060 LET Q=INT(T/M)
3070 LET R1=T-Q*M
3080 LET R2=R1/(M-1)
3090 REM *** SET THE SEED TO THE VALUE OF THE RANDOM INTEGER
3100 REM *** JUST GENERATED
3110 LET S=R1
3120 REM *** THIS INSURES THAT THE SERIES OF RANDOM REAL NUMBERS
3130 REM *** GENERATED FOR THE SAME INITIAL SEED WILL BE IDENTICAL.
3140 RETURN
3150 REM *****
3160 LET I=I+1
3170 IF P=2 THEN 3200
3180 PRINT
3190 PRINT "QUESTION. ";I
3200 RETURN
3210 PRINT "SORRY ";
3220 PRINT A$;
3230 PRINT ", PLEASE GET SOME HELP. SO LONG FOR NOW."
3240 STOP
3250 END

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Unit Test on Solving Stoichiometry Problems

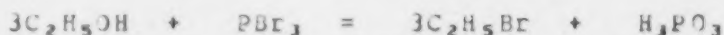
TEST 1

1.



IF WE START WITH 52.00 G OF NO_2 AND 1.04 MOLES OF H_2O IN THIS REACTION, AND 33.47 G OF HNO_3 ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD?

2.



STARTING WITH 24.15 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 20.13 G OF PBr_3 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H_3PO_3 WHICH CAN BE PRODUCED?

3.



HOW MANY GRAMS OF $\text{C}_2\text{H}_5\text{Br}$ IS THEORETICALLY OBTAINABLE FROM 3.078 G OF 9.399 % PURE PBr_3 ?

4.



HOW MANY GRAMS OF C_6H_6 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 3.67 MOLES OF CO_2 , IF THE REACTION HAS A YIELD OF 34.4 %?

5.



A STUDENT TAKES 97.30 G OF C_6H_6 AND REACTS IT WITH 2.39 MOLES OF O_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H_2O THAT COULD BE FORMED IN THIS EXPERIMENT?

6.



HOW MANY GRAMS OF NH_3 WOULD BE REQUIRED AS THE STARTING MATERIAL IN THE PREPARATION OF 56.95 GRAMS OF H_2O ?

7.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF Cu EXPECTED WHEN 36.70 G OF Cu_2S REACTS WITH 37.76 G OF Cu_2O ?

8.



IF WE START WITH 41.00 G OF H_3PO_4 AND 22.31 G OF $\text{Ba}(\text{OH})_2$, WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF $\text{Ba}_3(\text{PO}_4)_2$ WILL IT PRODUCE?

9.



HOW MANY GRAMS OF H_2 WAS REQUIRED TO MAKE 22.00 G OF
HF IF THE YIELD WAS 11.8%?

10.



A STUDENT REACTS 24.00 G OF NH_3 WITH 22.00 G OF
 O_2 . IF THE STUDENT ACTUALLY OBTAINS 8.23 G OF
 H_2O , WHAT IS THE PERCENT YIELD?

TEST 1

6. 3.59E+01

1. 7.05E+01

7. 5.03E+01

2. 6.10E+00

Ba(OH)₂

3. 3.50E-01

8. 4.34E-02

4. 1.39E+02

9. 9.32E+00

5. 1.72E+01

10. 5.54E+01

Unit Test on Solving Stoichiometry Problems

TEST 2

1.



HOW MANY GRAMS OF NH_3 WAS REQUIRED TO MAKE 38.00 G OF H_2O IF THE YIELD WAS 40.3%?

2.



IN AN EXPERIMENT, 3.92 MOLES OF H_3PO_4 ARE TREATED WITH EXCESS $\text{Ba}(\text{OH})_2$. THE H_2O OBTAINED WEIGHED 66.67 G. WHAT WAS THE PERCENT YIELD?

3.



HOW MANY GRAMS OF PCl_3 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 0.63 MOLES OF PF_3 , IF THE REACTION HAS A YIELD OF 82.3%?

4.



STARTING WITH 26.30 G OF Cu_2S AND 51.38 G OF Cu_2O , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF Cu WHICH CAN BE PRODUCED?

5.



A STUDENT TAKES 69.20 G OF ZnS AND REACTS IT WITH 3.82 MOLES OF O_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF ZnO THAT COULD BE FORMED IN THIS EXPERIMENT?

6.



CALCULATE THE NUMBER OF GRAMS OF ZnO WHICH CAN BE PRODUCED BY 2.47 MOLES OF ZnS.

7.



WHEN 1.46 MOLES OF PCl_3 AND 5.12 G OF PbF_2 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF PbCl_2 CAN BE EXPECTED?

8.



HOW MANY GRAMS OF H_2O CAN BE MADE FROM 102.70 GRAMS OF O_2 ?

9.



WHAT WEIGHT OF $\text{C}_2\text{H}_5\text{Br}$ IS THE THEORETICAL YIELD FROM
39.10 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 3.92 MOLES OF PBr_3 ?

10.



IN THIS REACTION, 36.00 G OF CaO AND 66.00 G OF C
RESULTS IN AN ACTUAL YIELD OF 26.7 %. HOW MANY GRAMS OF
 CaC_2 ARE OBTAINED ?

TEST 2

6. 2.01E+02

1. 5.94E+01

 PbF_2
7. 5.81E+00

2. 3.15E+01

8. 6.93E+01

3. 1.05E+02

4. 6.30E+01

9. 9.26E+01 G

5. 5.78E+01

10. 1.10E+01

Unit Test on Solving Stoichiometry Problems

TEST

3

1.



IN AN EXPERIMENT, 4.05 MOLES OF H_3PO_4 ARE TREATED WITH EXCESS $\text{Ba}(\text{OH})_2$. THE H_2O OBTAINED WEIGHED 17.49 G. WHAT WAS THE PERCENT YIELD?

2.



STARTING WITH 7.65 G OF ZnS AND 49.08 G OF O_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF ZnO WHICH CAN BE PRODUCED?

3.



HOW MANY GRAMS OF H_2O IS THEORETICALLY OBTAINABLE FROM 6.094 G OF 60.397% PURE Fe_2O_3 ?

4.



HOW MANY MOLES OF H_2O CAN WE EXPECT FROM A REACTION BETWEEN 2.03 MOLES OF NH_3 AND 4.85 MOLES OF O_2 ?

5.



CALCULATE THE NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED BY 4.32 MOLES OF O_2 .

6.



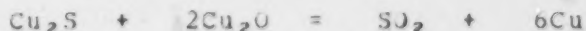
IF WE START WITH 12.00 G OF NO_2 AND 3.97 MOLES OF H_2O IN THIS REACTION, AND 0.55 G OF NO ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD?

7.



A STUDENT REACTS 19.00 G OF $\text{C}_3\text{H}_8\text{O}$ WITH 74.00 G OF O_2 . IF THE STUDENT ACTUALLY OBTAINS 8.39 G OF H_2O , WHAT IS THE PERCENT YIELD?

8.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF SO_2 EXPECTED WHEN 51.00 G OF Cu_2S REACTS WITH 31.26 G OF Cu_2O ?

9.



WHAT WEIGHT OF Xe IS THE THEORETICAL YIELD FROM
19.75 G OF XeF₄ AND 1.72 MOLES OF H₂ ?

10.



IN THIS REACTION, 43.00 G OF H₃PO₄ AND 77.00 G OF Ba(OH)₂
RESULTS IN AN ACTUAL YIELD OF 5.1 %. HOW MANY GRAMS OF
H₂O ARE OBTAINED ?

TEST 3

6. 2.09E+01

7. 3.68E+01

1. 8.00E+00

8. 6.99E+00

2. 6.39E+00

3. 1.24E+00

9. 1.25E+01 G

4. 3.04E+00

10. 8.25E-01

5. 1.04E+02

Unit Test on Solving Stoichiometry Problems

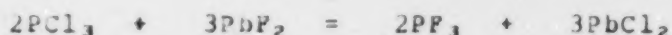
TEST 4

1.



HOW MANY GRAMS OF Cu CAN BE MADE FROM 72.10 GRAMS OF Cu_2S ?

2.



HOW MANY GRAMS OF PbF_2 WAS REQUIRED TO MAKE 47.00 G OF PF_3 IF THE YIELD WAS 68.8%?

3.



WHEN 2.45 MOLES OF $\text{C}_3\text{H}_8\text{O}$ AND 11.50 G OF O_2 ARE MADE TO REACT, WHICH ONE IS THE LIMITING REAGENT AND HOW MANY GRAMS OF H_2O CAN BE EXPECTED?

4.



HOW MANY MOLES OF Fe CAN BE FORMED BY THE REACTION OF 5.37 MOLES OF H_2 WITH Fe_2O_3 IF THE LATTER IS IN EXCESS?

5.



IN THIS REACTION, 20.00 G OF XeF_4 AND 15.00 G OF H_2 RESULTS IN AN ACTUAL YIELD OF 10.3 %. HOW MANY GRAMS OF Xe ARE OBTAINED?

6.



WHAT WEIGHT OF PF_3 IS THE THEORETICAL YIELD FROM 33.70 G OF PCl_3 AND 0.61 MOLES OF PbF_2 ?

7.



A STUDENT REACTS 16.00 G OF PCl_3 WITH 5.00 G OF PbF_2 . IF THE STUDENT ACTUALLY OBTAINS 0.34 G OF PF_3 , WHAT IS THE PERCENT YIELD?

8.



IN AN EXPERIMENT, 2.92 MOLES OF NH_3 ARE TREATED WITH EXCESS O_2 . THE H_2O OBTAINED WEIGHED 56.29 G. WHAT WAS THE PERCENT YIELD?

9.



HOW MANY MOLES OF H_2O CAN WE EXPECT FROM A REACTION BETWEEN
3.33 MOLES OF C_6H_6 AND 1.74 MOLES OF O_2 ?

10.



STARTING WITH 47.40 G OF NH_3 AND 18.40 G OF O_2 ,
WHAT IS THE MAXIMUM NUMBER OF GRAMS OF NO WHICH CAN BE PRODUCED ?

TEST 4

6. 2.16E+01 G

1. 1.73E+02

7. 2.88E+01

2. 2.86E+02

8. 7.14E+01

3. ^{O₂} 5.75E+00

4. 3.58E+00

9. 6.96E-01

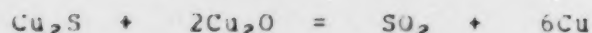
5. 1.30E+00

10. 1.38E+01

Unit Test on Solving Stoichiometry Problems

TEST 5

1.



HOW MANY GRAMS OF Cu_2S ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 2.60 MOLES OF SO_2 , IF THE REACTION HAS A YIELD OF 53.0 % ?

2.



HOW MANY GRAMS OF CaO WAS REQUIRED TO MAKE 8.00 G OF CaC_2 IF THE YIELD WAS 54.0% ?

3.



IN AN EXPERIMENT, 1.63 MOLES OF NO_2 ARE TREATED WITH EXCESS H_2O . THE HNO_3 OBTAINED WEIGHED 38.47 G. WHAT WAS THE PERCENT YIELD ?

4.



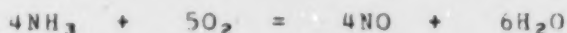
IF WE START WITH 8.20 G OF C_6H_6 AND 45.66 G OF O_2 , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF CO_2 WILL IT PRODUCE ?

5.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF ZnO EXPECTED WHEN 16.75 G OF ZnS REACTS WITH 34.15 G OF O_2 ?

6.



STARTING WITH 29.15 G OF NH_3 AND 49.72 G OF O_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H_2O WHICH CAN BE PRODUCED ?

7.



HOW MANY GRAMS OF HF IS THEORETICALLY OBTAINABLE FROM 2.336 G OF 91.048 % PURE H_2 ?

8.



HOW MANY MOLES OF $\text{Ba}_3(\text{PO}_4)_2$ CAN BE FORMED BY THE REACTION OF 2.90 MOLES OF H_3PO_4 WITH $\text{Ba}(\text{OH})_2$ IF THE LATTER IS IN EXCESS?

9.



WHAT WEIGHT OF Fe IS THE THEORETICAL YIELD FROM
16.10 G OF H_2 AND 4.00 MOLES OF Fe_2O_3 ?

10.



PbCl_2 WAS PREPARED BY TREATING 23.00 G OF PCl_3 WITH
EXCESS PbF_2 . THE PbCl_2 COLLECTED WEIGHED 9.43 G.
WHAT WAS THE PERCENT YIELD ?

TEST 5

6. 3.36E+01

1. 7.80E+02

7. 4.26E+01

2. 1.30E+01

8. 1.45E+00

3. 5.62E+01

C_6H_6
4. 6.31E-01

9. 3.01E+02 G

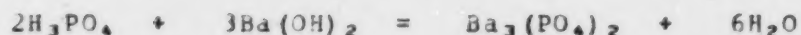
5. 1.40E+01

10. 1.35E+01

Unit Test on Solving Stoichiometry Problems

TEST 6

1.



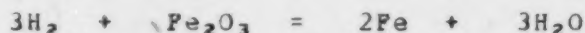
HOW MANY GRAMS OF H_3PO_4 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 1.95 MOLES OF H_2O , IF THE REACTION HAS A YIELD OF 57.3 % ?

2.



IF WE START WITH 10.15 G OF $\text{C}_3\text{H}_8\text{O}$ AND 10.67 G OF O_2 , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF H_2O WILL IT PRODUCE ?

3.



HOW MANY MOLES OF Fe CAN WE EXPECT FROM A REACTION BETWEEN 3.91 MOLES OF H_2 AND 4.28 MOLES OF Fe_2O_3 ?

4.



A STUDENT TAKES 27.10 G OF H_3PO_4 AND REACTS IT WITH 4.55 MOLES OF $\text{Ba}(\text{OH})_2$. WHAT IS THE MAXIMUM NUMBER OF GRAMS OF $\text{Ba}_3(\text{PO}_4)_2$ THAT COULD BE FORMED IN THIS EXPERIMENT ?

5.



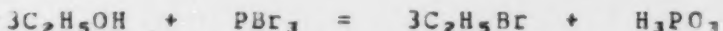
HOW MANY GRAMS OF PCl_3 WOULD BE REQUIRED AS THE STARTING MATERIAL IN THE PREPARATION OF 43.20 GRAMS OF PF_3 ?

6.



HOW MANY GRAMS OF H_2O IS THEORETICALLY OBTAINABLE FROM 3.477 G OF 27.899 % PURE $\text{Ba}(\text{OH})_2$?

7.



H_3PO_3 WAS PREPARED BY TREATING 48.00 G OF $\text{C}_2\text{H}_5\text{OH}$ WITH EXCESS PBr_3 . THE H_3PO_3 COLLECTED WEIGHED 27.10 G. WHAT WAS THE PERCENT YIELD ?

8.



HOW MANY GRAMS OF ZnS WAS REQUIRED TO MAKE 15.00 G OF SO_2 IF THE YIELD WAS 49.1% ?

9.



WHAT WEIGHT OF $\text{C}_2\text{H}_5\text{Br}$ IS THE THEORETICAL YIELD FROM
11.50 G OF $\text{C}_2\text{H}_5\text{OH}$ AND 4.81 MOLES OF PBr_3 ?

10.



A STUDENT REACTS 35.00 G OF $\text{C}_2\text{H}_5\text{OH}$ WITH 25.00 G OF
 PBr_3 . IF THE STUDENT ACTUALLY OBTAINS 2.14 G OF
 H_3PO_3 , WHAT IS THE PERCENT YIELD?

TEST

6

6. 2.04E-01

1. 1.10E+02

7. 9.50E+01

2. ⁰²2.96E-01

3. 2.61E+00

8. 4.65E+01

9. 2.72E+01 G

4. 8.32E+01

10. 2.83E+01

5. 6.74E+01

Unit Test on Solving Stoichiometry Problems

TEST 7

1.



IN THIS REACTION, 52.00 G OF H_2 AND 71.00 G OF Fe_2O_3 RESULTS IN AN ACTUAL YIELD OF 79.6 %. HOW MANY GRAMS OF Fe ARE OBTAINED ?

2.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF PF_3 EXPECTED WHEN 49.15 G OF PCl_3 REACTS WITH 29.72 G OF PbF_2 ?

3.



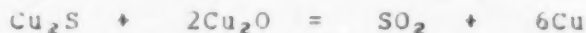
HOW MANY GRAMS OF Cu_2S WOULD BE REQUIRED AS THE STARTING MATERIAL IN THE PREPARATION OF 36.80 GRAMS OF Cu?

4.



IF WE START WITH 23.10 G OF Cu_2S AND 41.54 G OF Cu_2O , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF SO_2 WILL IT PRODUCE ?

5.



IF WE START WITH 20.00 G OF Cu_2S AND 4.88 MOLES OF Cu_2O IN THIS REACTION, AND 1.56 G OF SO_2 ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

6.



STARTING WITH 25.75 G OF XeF_4 AND 16.15 G OF H_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF Xe WHICH CAN BE PRODUCED ?

7.



A STUDENT TAKES 16.40 G OF H_2 AND REACTS IT WITH 0.91 MOLES OF Fe_2O_3 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF Fe THAT COULD BE FORMED IN THIS EXPERIMENT ?

8.



HOW MANY GRAMS OF CaO WAS REQUIRED TO MAKE 19.00 G OF CO IF THE YIELD WAS 54.5% ?

9.



HOW MANY GRAMS OF ZnS ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 1.42 MOLES OF ZnO, IF THE REACTION HAS A YIELD OF 78.0 % ?

10.



HOW MANY MOLES OF H₂O CAN BE FORMED BY THE REACTION OF 4.83 MOLES OF H₂ WITH Fe₂O₃ IF THE LATTER IS IN EXCESS?

TEST 7

6. 1.63E+01

1. 3.96E+01

7. 1.02E+02

2. 7.11E+00

3. 1.54E+01

8. 6.98E+01

^{Cu₂O}
4. 1.45E-01

9. 1.77E+02

5. 1.94E+01

10. 4.83E+00

Unit Test on Solving Stoichiometry Problems

TEST 8

1.



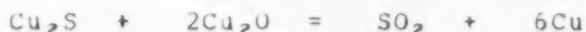
HOW MANY MOLES OF $\text{C}_2\text{H}_5\text{Br}$ CAN WE EXPECT FROM A REACTION BETWEEN 4.96 MOLES OF $\text{C}_2\text{H}_5\text{OH}$ AND 1.93 MOLES OF PBr_3 ?

2.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF $\text{C}_2\text{H}_5\text{Br}$ EXPECTED WHEN 47.00 G OF $\text{C}_2\text{H}_5\text{OH}$ REACTS WITH 12.21 G OF PBr_3 ?

3.



HOW MANY GRAMS OF Cu_2O WOULD BE REQUIRED AS THE STARTING MATERIAL IN THE PREPARATION OF 23.35 GRAMS OF SO_2 ?

4.



A STUDENT TAKES 35.00 G OF $\text{C}_3\text{H}_8\text{O}$ AND REACTS IT WITH 2.19 MOLES OF O_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF H_2O THAT COULD BE FORMED IN THIS EXPERIMENT?

5.



SO_2 WAS PREPARED BY TREATING 14.00 G OF Cu_2S WITH EXCESS Cu_2O . THE SO_2 COLLECTED WEIGHED 3.01 G. WHAT WAS THE PERCENT YIELD?

6.



HOW MANY GRAMS OF ZnO IS THEORETICALLY OBTAINABLE FROM 1.398 G OF 27.698 % PURE O_2 ?

7.



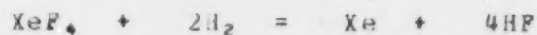
A STUDENT REACTS 10.00 G OF H_3PO_4 WITH 56.00 G OF $\text{Ba}(\text{OH})_2$. IF THE STUDENT ACTUALLY OBTAINS 27.91 G OF $\text{Ba}_3(\text{PO}_4)_2$, WHAT IS THE PERCENT YIELD?

8.



HOW MANY GRAMS OF Fe_2O_3 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 3.44 MOLES OF H_2O , IF THE REACTION HAS A YIELD OF 64.9 %?

9.



IF WE START WITH 38.00 G OF XeF_4 AND 1.67 MOLES OF H_2 IN THIS REACTION, AND 3.51 G OF HF ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

10.



STARTING WITH 52.90 G OF $\text{C}_3\text{H}_8\text{O}$ AND 15.86 G OF O_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF CO_2 WHICH CAN BE PRODUCED ?

TEST 8

6. 6.57E-01

1. 4.96E+00

7. 9.09E+01

2. 1.48E+01

3. 1.04E+02

8. 2.83E+02

4. 3.50E+01

9. 5.87E+01

5. 5.34E+01

10. 1.45E+01

Unit Test on Solving Stoichiometry Problems

TEST 9

1.



IN THIS REACTION, 12.00 G OF NO_2 AND 7.00 G OF H_2O RESULTS IN AN ACTUAL YIELD OF 81.2 %. HOW MANY GRAMS OF HNO_3 ARE OBTAINED ?

2.



HOW MANY MOLES OF NO CAN BE FORMED FROM 61.10 G OF H_2O ?

3.



IN AN EXPERIMENT, 4.80 MOLES OF C_6H_6 ARE TREATED WITH EXCESS O_2 . THE H_2O OBTAINED WEIGHED 213.84 G. WHAT WAS THE PERCENT YIELD ?

4.



IF WE START WITH 46.05 G OF NO_2 AND 9.42 G OF H_2O , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF HNO_3 WILL IT PRODUCE ?

5.



A STUDENT TAKES 63.60 G OF ZnS AND REACTS IT WITH 0.88 MOLES OF O_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF ZnO THAT COULD BE FORMED IN THIS EXPERIMENT ?

6.



HOW MANY MOLES OF CaC_2 CAN WE EXPECT FROM A REACTION BETWEEN 4.72 MOLES OF CaO AND 1.68 MOLES OF C ?

7.



IF WE START WITH 21.00 G OF CaO AND 0.86 MOLES OF C IN THIS REACTION, AND 4.15 G OF CO ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

8.



H_3PO_3 WAS PREPARED BY TREATING 16.00 G OF $\text{C}_2\text{H}_5\text{OH}$ WITH

EXCESS PBr_3 . THE H_3PO_3 COLLECTED WEIGHED 6.26 G.
WHAT WAS THE PERCENT YIELD ?

9.



STARTING WITH 33.20 G OF CaO AND 29.49 G OF C,
WHAT IS THE MAXIMUM NUMBER OF GRAMS OF CO WHICH CAN BE PRODUCED ?

10.



HOW MANY GRAMS OF H_2 WOULD BE REQUIRED AS THE STARTING MATERIAL
IN THE PREPARATION OF 47.85 GRAMS OF H_2O ?

TEST 9

6. 5.60E-01

1. 8.90E+00

7. 5.17E+01

2. 3.39E+00

3. 8.25E+01

8. 6.58E+01

4. NO_2 6.67E-01

9. 1.66E+01

5. 4.77E+01

10. 5.32E+00

Unit Test on Solving Stoichiometry Problems

TEST 10

1.



WHAT IS THE THEORETICAL YIELD, IN GRAMS, OF $\text{C}_2\text{H}_5\text{Br}$ EXPECTED WHEN 14.95 G OF $\text{C}_2\text{H}_5\text{OH}$ REACTS WITH 8.52 G OF PBr_3 ?

2.



HOW MANY GRAMS OF NH_3 ARE NEEDED AS THE STARTING MATERIAL FOR THE PREPARATION OF 0.62 MOLES OF H_2O , IF THE REACTION HAS A YIELD OF 87.6 % ?

3.



IF WE START WITH 46.65 G OF NH_3 AND 18.63 G OF O_2 , WHICH IS THE LIMITING REAGENT AND HOW MANY MOLES OF NO WILL IT PRODUCE ?

4.



A STUDENT TAKES 23.60 G OF XeF_4 AND REACTS IT WITH 3.10 MOLES OF H_2 . WHAT IS THE MAXIMUM NUMBER OF GRAMS OF HF THAT COULD BE FORMED IN THIS EXPERIMENT ?

5.



IF WE START WITH 54.00 G OF NH_3 AND 4.53 MOLES OF O_2 IN THIS REACTION, AND 41.83 G OF NO ARE ACTUALLY FORMED, WHAT IS THE PERCENT YIELD ?

6.



IN THIS REACTION, 7.00 G OF XeF_4 AND 6.00 G OF H_2 RESULTS IN AN ACTUAL YIELD OF 81.6 %. HOW MANY GRAMS OF HF ARE OBTAINED ?

7.



HOW MANY GRAMS OF CO_2 IS THEORETICALLY OBTAINABLE FROM 1.094 G OF 76.398 % PURE C_6H_6 ?

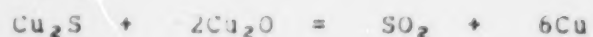
8.



HOW MANY GRAMS OF CaO WOULD BE REQUIRED AS THE STARTING MATERIAL

IN THE PREPARATION OF 42.15 GRAMS OF CO?

9.



IN AN EXPERIMENT, 4.93 MOLES OF Cu_2S ARE TREATED WITH EXCESS Cu_2O . THE Cu OBTAINED WEIGHED 052.63 G. WHAT WAS THE PERCENT YIELD?

10.



STARTING WITH 25.25 G OF C_6H_6 AND 42.87 G OF O_2 , WHAT IS THE MAXIMUM NUMBER OF GRAMS OF CO_2 WHICH CAN BE PRODUCED?

TEST 10

6. 2.20E+00

1. 1.03E+01

7. 2.83E+00

2. 8.02E+00

3. ^{O₂} 4.66E-01

8. 8.44E+01

4. 9.11E+00

9. 5.60E+01

5. 4.39E+01

10. 4.72E+01